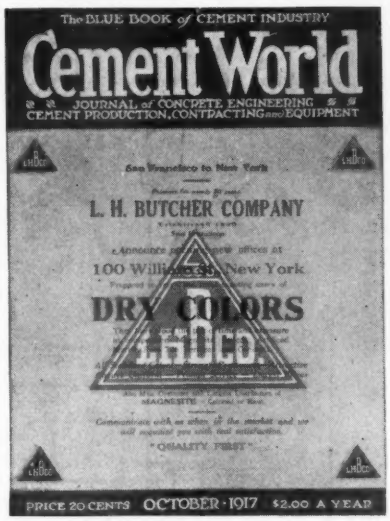
COMPRESSED AIR MAGAZINE

DEVOTED TO THE USEFUL APPLICATIONS OF COMPRESSED AIRY

Vol. xxiii MARCH, 1918 No. 3



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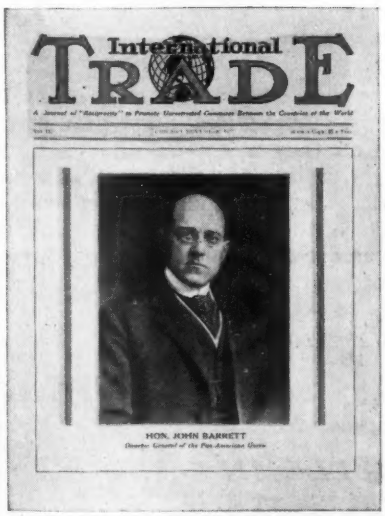

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Classified Buyers' Guide, Page 14. Index to Advertisers, Page 11

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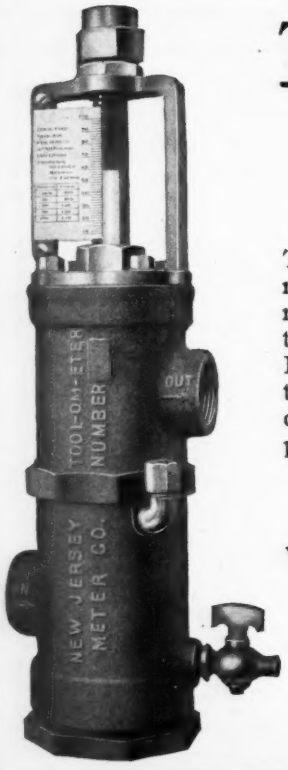

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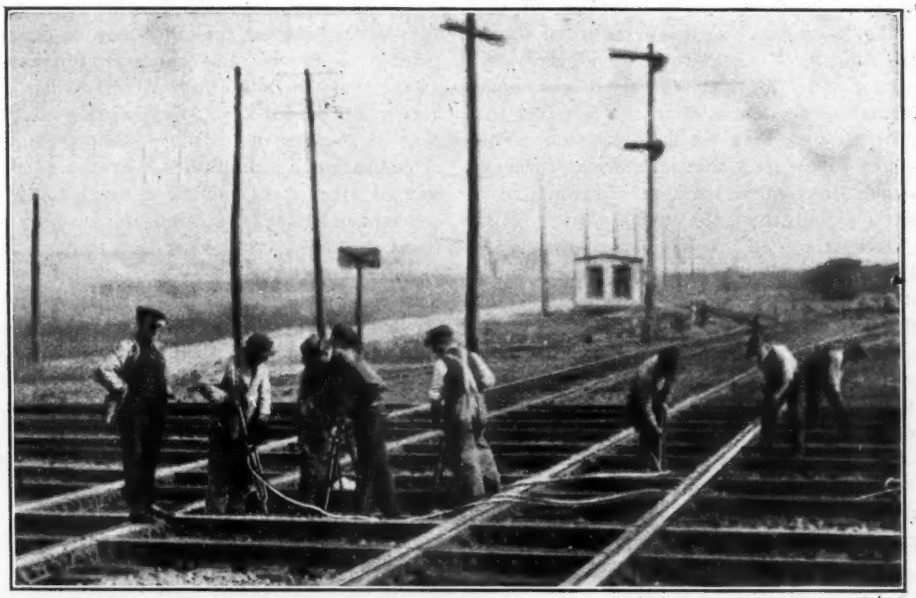
COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

Vol. xxiii MARCH, 1918 No. 3



TAMPING A SET OF CROSSINGS

SCARCITY OF MEN AND GROWING USE OF AIR IN RAILROAD MAINTENANCE*

In the present acute labor shortage with men practically unobtainable at reasonable rates in sufficient numbers to carry on even the most urgent work, compressed air is of particular advantage to the maintenance of way department because of its adaptability to various kinds of maintenance work.

PNEUMATIC TIE TAMPERS

What has now come to be the most common use of compressed air in railroad maintenance is in the work of tie tamping. The tamping tools may be operated either by utilizing existing air lines, as in the case of the Pennsylvania, where a permanent installation of air for use in connection with pneumatic switch and signal systems and other purposes is available in the mainline territory between New York and Pittsburgh, or in connection with portable gasolene-driven air compressors provided for the purpose.

PORTABLE COMPRESSORS

Many of the large eastern roads, including the Lackawanna and the Lehigh Valley, are using tamping outfits operated in connection with portable compressors. The first outfits were installed on the Lackawanna in the summer of 1916, when five outfits of the four-tool type were placed in service on the west end of the Buffalo division as a test installation. These outfits were placed on alternating sec-

*Condensed from Railway Maintenance Engineer.

tions to test out their efficiency as compared with hand tamping on the adjoining sections, and as the result of this test 25 additional outfits were purchased and placed in service in June, 1917. With these outfits, in addition to the first five, the 217 miles of main line between Halsted, Pa., and Buffalo, N. Y., was completely equipped, leaving the 179 miles of main line between Hoboken, N. J., and Halsted unequipped.

DIFFERENT CONDITIONS OF HAND AND MACHINE WORK

In 1917 the gangs were short-handed and the labor employed was below the usual standards, causing a decline in gang efficiency. Working under these conditions, it was found that machine work was done at a less cost and was better done than the hand tamping. This was due to the fact that an efficient foreman was able to control the machine work to a greater extent than the hand work. With the machine a good job is a matter of position and time of tamping, which the foreman could control, thus in a measure overcoming the inefficiency of the labor, while with hand tamping it is a matter of strength and willingness as well, both of which are beyond the control of the foreman. The outfits were found to be especially valuable for gangs which were short handed because of the greater output of work units per man. With six men to the section as a minimum a foreman was able to keep his track in good line and surface and, because of the superior work of the tamper, once the track was in shape it held better.

MOST EFFICIENT ON THE MOST DIFFICULT WORK

The tampers were found particularly efficient in complicated track work as in yards and at interlocking plants where hand tamping is practically impossible. They were also found to be economical in resurfacing as loose ties may be tamped without digging out the ballast when the work is done with the machines. With hand tamping this digging out is necessary to tamp the ties properly.

SELF ADVERTISING TOOLS

On the strength of the results obtained early in 1917, the Lackawanna purchased 25 additional outfits. These have been delivered and 7 more are now under construction, making a total of 62 outfits in all. With these placed in service the entire main line between Hoboken and Buffalo will be equipped.

OTHER COMPRESSED AIR USES

The Lehigh Valley utilizes the compressors the year around. In winter they are employed on the line to supply air to boilermakers' tools, thus releasing locomotives generally used for this purpose. They are also used by the bridge and building department in sawing and boring bridge and other timbers and it is proposed to utilize them for operating saws for cutting timbers. Compressors have also been utilized by the Lehigh Valley to supply air to train lines in yards where the regular equipment was one of order or the supply was insufficient. Here again they replaced locomotives.

By the substitution of a suitable bit or chisel for the tamping bar the outfit may be used for cutting pavements and concrete foundations away from the rails in city streets as has been previously described. On railways with track pans on the line the cutting tools may be used in combating ice conditions. By the substitution of other tools for the tamping tools, the compressor may be utilized in cleaning rust from steel, as a sand blast, for painting steel or other structures.

In placing the rail on the 26 miles of line of the New York Connecting Railway, the compressors were used in connection with Ingersoll-Rand Little David No. 11 S. E. reversible drills in placing screw spikes. Exclusive of the overhead expense and the depreciation the cost per spike placed by this method averaged $0.008.

NOVEL ROCK CUTTING JOB

The Pennsylvania Railroad recently employed air in a novel way for widening a rock cut on its line between East Liberty, Pa., and Pittsburgh. The rock removed is known as Pittsburgh shale and, while soft and having decided cleavages, is hard enough to make its removal by hand picks difficult. The local restrictions prevented the use of explosives and as the work was of considerable magnitude, being 400 ft. long with a thickness ranging from 10 to 25 ft., it was decided to utilize tamping tools fitted with bars with pick points in place of the tamping bars to remove the rock.

Rope slings to support the men and tools were attached to the fence at the top of the cut and, together with an air hose, were strung along the face of the cut. The work commenced at the top of the wall and progressed downward in shelves, each cut being made to the full depth back to the permanent face. The operator picked downward through the rock for a distance of about 8 in. and then drove

NOVEL ROCK CUTTING JOB

the pick into the horizontal seam, breaking the rock off in layers about 6 in. thick.

Owing to its brittle nature the rock broke off in comparatively small pieces, which became further broken up in the downward course into gondola cars which were placed alongside the work. Inclined plank aprons were provided to enable the spoil to be loaded into the cars with the least effort. The method of placing the slings and the loading of the material are shown in the photograph. The air supply for the tools was obtained from the supply line which is used in connection with the signal system.

RECENT DEVELOPMENTS IN AIR TOOLS

Two air-operated tools which are applicable to maintenance work have recently been perfected by the Ingersoll-Rand Company, and are

PNEUMATIC SPIKE DRIVER

PNEUMATIC RAIL DRILL

now in use on several of the eastern roads. The tools are a spike-driving hammer for seating cut spikes and a pneumatic rail drill, which is used for drilling rails for joints and for bonding.

SPIKE DRIVER

The pneumatic spike driver is larger than the riveting hammers familiar to railway men. The complete machine is 25 in. long and weighs slightly more than 60 lb. It strikes a slow, hard blow under the positive control of a trigger located on the inside of the T handle and when starting the spikes it is possible to throttle the hammer blow to a light tap. The piston of the tool transmits the driving force through an interposed hammer block, which is cupped out to accommodate the head of the spike. From a time-saving point of view it has been found most efficient to start the spikes by hand and finish the driving by the machine. It takes approximately five seconds to drive home a spike. One man with a spike driver can follow three men starting spikes and drive home all they can set up.

PNEUMATIC DRILL AND "OLD MAN"

The pneumatic drill, which is known as the No. 9 "Little David," is equipped with a three-cylinder motor, giving it a constant power impulse. It weighs 37 lb. and operates at a speed of 140 r.p.m. The spindle socket accommodates No. 4 Morse taper shanks. As shown in the photograph, a lever type "Old Man" has been developed for use in attaching the drilling machine to the rail. Its quick clamping action minimizes the time required for a set up and the constant pressure drill feed is a further advantage. Observations for actual drilling speed show an average of 45 sec. required for an 80-lb. rail and 1 min. 20 sec. for a 120-lb. rail.

INGENIOUS SOLUTION OF DIFFICULT SALVAGE PROBLEM

Marine records contain very few instances in which overturned and sunken ships have been refloated. A vessel in that position presents a very awkward mass to handle. One of the foremost difficulties is that of controlling the water inside of the craft when the ship is righting herself and rising to the surface. The surging water may all too easily upset the boat's stability at a critical moment in the operations and heel her over so far that she will refill and sink again, possibly bottomside up.

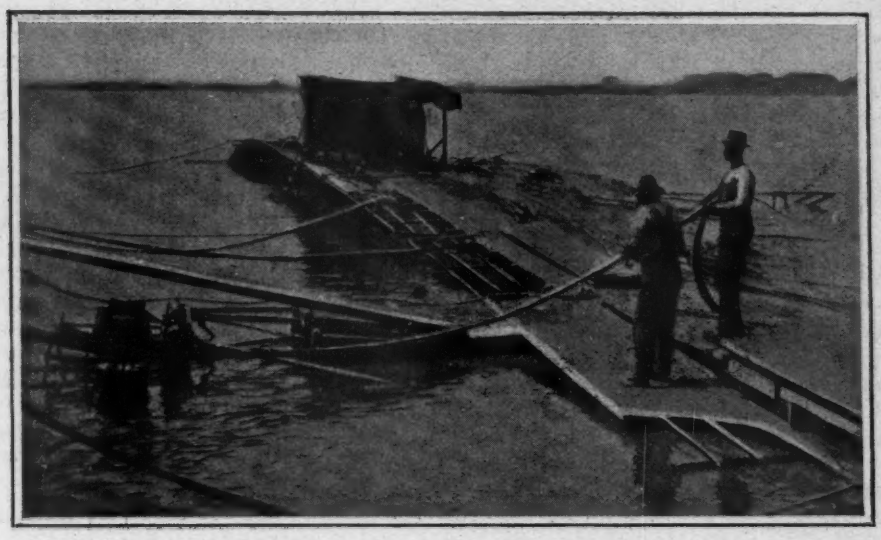
The recent salvage of the German tanker

THE GUT HEIL AFLOAT

"Gut Heil" is of especial interest because the ship was commonly considered a total loss and a hopeless task for wreckers. The vessel foundered in the latter part of 1912 just after leaving the dock at Baton Rouge with a full load of $3,800 tons of oil. A chain cable fouled her propeller, and while unmanageable, the steamer was carried by the current down upon two other vessels. Each tore a hole in the "Gut Heil's" port side, and through these wounds the waters of the Mississippi flooded into her. Sometime afterwards, her underwriters, the Standard Oil Company, tried to raise her. They succeeded up to a point, but the free surface of the water inside of her invited disaster—the fluid ballast started the craft heeling, and before her angular movement could be arrested, she rolled over, refilled, and sank to the riverbed on her injured side. The efforts to refloat her entailed an outlay of more than $100.000.

Nothing further was done by her underwriters save to recover some of the bulk oil she carried. After that, the tanker was abandoned, and just because she did not seriously interfere with navigation the United States authorities failed to dispose of her by blowing her up, as is generally done with derelicts. In the course of four years and more, the mud of the Mississippi worked into the sunken vessel and loaded her with substantially 4,000 tons of silt, adding just that much more to the improbability of ever raising the steamer. Such were the general conditions when a New York salvage concern was asked a few months ago to try to refloat the ship. The problem presented a number of angles which had to be dealt with successively in order to bring about a state of affairs that would favor her ultimate recovery.

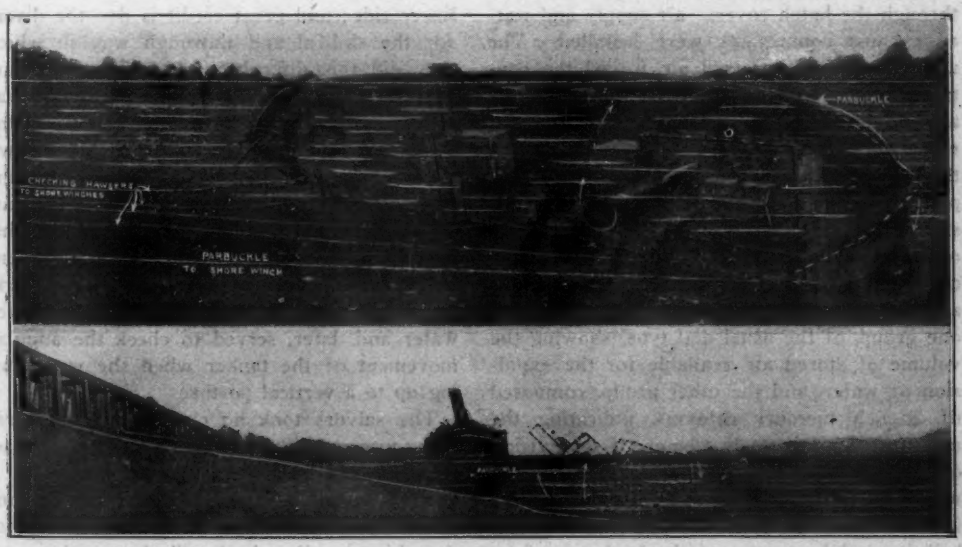
First, the mud inside of her had to be removed; second, the two injuries had to be closed and the tanker otherwise made structurally tight so that compressed air could be used for the final expulsion of the water inside of her; third, it was needful that the distribution



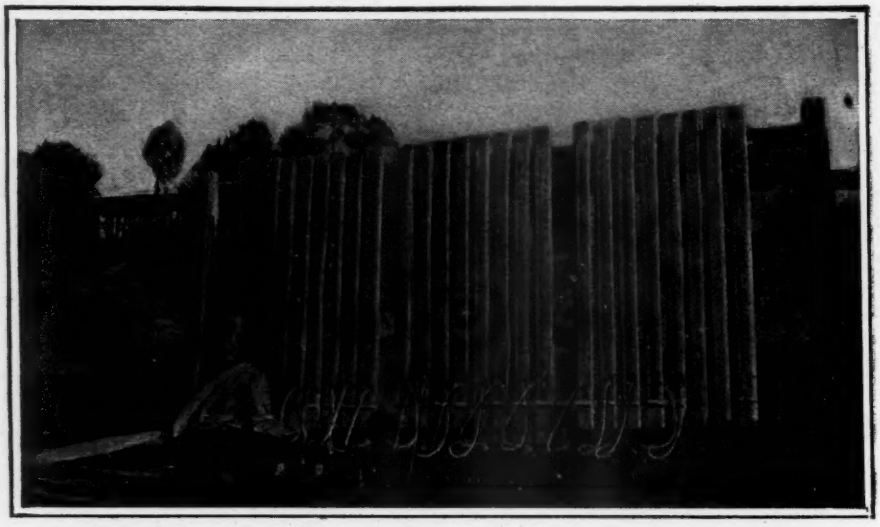
SIDE OF GUT HEIL JUST OUT OF WATER

of water ballast and buoyancy should be susceptible of extremely nice control throughout all of the steamer's compartments; and, finally very positive checks had to be provided to hold the boat from acquiring a sudden excess heel through the momentum induced when swinging into a vertical position.

To free the "Gut Heil" of mud, the wreckers devised an ingenious and very effective compressed air siphon. This apparatus served the double purpose of loosening the mud and then raising it to the surface. The siphon handled the problem a good deal better than the available types of salvage pumps. With 3,000 tons of the silt thus removed it was possible for divers to enter the vessel and examine her structural condition. They found that her main longitudinal bulkhead was only loosely connected with the two decks above and, therefore unsuited in that state to isolate the neigh-



SKETCH OF THE GUT HEIL AS SHE LAY AND OF THE MANNER OF RIGHTING



MERCURY TUBES FOR WATCHING THE PRESSURE IN THE COMPARTMENTS

boring compartments so that they might be dealt with separately in applying compressed air for the final expulsion of their contained water. Binders of reinforced concrete, fixed in position while the tanker lay submerged, tied the decks and the bulkhead together and effectually sealed the joints. Reinforced concrete patches, put in position under water, also closed the two wounds in the hull plating caused by the collisions.

To each compartment—in most instances through the hatch covers—air supply and water exhaust connections were installed. The admission of compressed air forced the contained water outboard, and the release of the air pressure permitted the re-entry of the water. The air was supplied by hose, and all of these conduits were centered at a swinging platform erected upon the rail of the upturned side of the ship. Each lead of hose was there operated by its own valve, tapping flasks duly charged for the service. Upon this same operating stage were installed two groups of gages: one group, of the usual dial type, showing the volume of stored air available for the expulsion of water, and the other group, composed of 40-inch mercury columns, indicating the measure of air in each submerged subdivision of the vessel. This arrangement provided the wrecking master with a visible record of the internal distribution of buoyancy and water ballast; and by means of the bank of valves immediately at hand it was possible for him to make instant and very nice adjustments of these opposing forces as the movement of the craft necessitated.

But notwithstanding this seemingly complete equipment, the wreckers determined to take no chances. Therefore they secured to her at several points wire rope purchases which were led ashore to tackles attached to 40-ton blocks of cement buried in the ground. The tackles were operated by power-driven winches. Five of these purchases were made fast to mooring bits on the deck of the tanker on her lower side; and great credit is due the divers for the skillful and thorough way in which they did this difficult work. The sixth purchase in the form of a salvor's parbuckle, was secured to a deck bit on the upper side of the deck, then led over the upturned side, down through the propeller well, thence under the ship, and from there to the shore. The latter purchase made it possible to exert a righting force, while the five other purchases enabled the wreckers, at one stage of the work, to draw the ship shoreward into shallower water and, later, served to check the angular movement of the tanker when she was coming up to a vertical posture.

The salvors took no chances, as the foregoing preparations make plain, and it was wise, because they were thus able to deal with a number of unexpected contingencies. For instance, while the compressed air siphons functioned very well, indeed, still about a thousand tons of mud remained in the craft clinging to the upper surfaces of compartments at the time

righting operations were started. When the steamer was beginning to free herself from the bottom and to turn on her longitudinal axis, this mud dropped away from its resting places and fell to the lower sides of the several subdivisions. This radically altered the "Gut Heil's" center of gravity, and for a while effectually arrested her angular motion. However, her changed position vertically gave the wreckers a chance to pull her farther inshore where she grounded and took a still better posture for subsequent work upon her.

When the ship was finally restored to an even keel, but while still resting upon the riverbed, it was discovered that the hole through the hull into the engine room had not been perfectly sealed by the reinforced concrete patch placed over it by the divers. That is to say, there was a leak which made it impossible to fill the space with compressed air in order to drive out the contained water. Therefore, it was decided to drain the engine room by suction pumps, and the leak was successfully stopped by means of a canvas patch applied externally. This patch was reinforced by strips of wood placed horizontally which, while stiffening the fabric and holding it stretched, left it flexible enough to adjust itself to inequalities of surface where the steel plating had been torn at the time of collision. This may seem an unimportant detail, but that expedient shows how it may be possible to deal quickly with a wound in any of our fighting ships or damaged war freighters. The usual woven mattress of hempen cable, such as is generally advocated in the naval service, is a clumsy thing to handle and not susceptible of rapid fabrication.

The "Gut Heil" is a vessel 321 feet long; and on a 21-foot draft carries 3,800 tons of oil. As she lay submerged she represented a dead weight of substantially 6,000 tons. The wreckers were engaged about two months in their preparations and the ultimate refloating of the craft. The latter operation was carried through in the course of a single day. When sunk, in 1912, the ship was valued at approximately $300,000. Today, she would bring a round million of dollars. Notwithstanding her five years' submergence, she is structurally sound, and her machinery, though very dirty, is in excellent condition. The turning over and refloating of the tanker, although commonly considered an impossible wrecking feat, illustrates what the resourceful scientific salvor can achieve now in the face of many physical difficulties; and it emphasizes the part certainly to be played by the wrecker in restoring to service ships that are sunk by routine mishaps or sent to the bottom by the ravaging submarine. —*Scientific American.*

MILLIONS OF TONS OF COAL SAVED BY SOOT BLOWERS

A recent statement by the Diamond Power Specialty Company, Detroit, points out that its mechanical soot blowers saved the nation 2,200,000 tons of coal during 1917 by keeping heating surfaces clean, and in this way enabling more efficient heat transfer from furnace gases to boiler heating surfaces. This company reports at a conservative estimate about 11,000,000 boiler horsepower in the United States are being maintained efficient by Diamond soot blowers. If these boilers average 2500 hours operation yearly, and allowing 4 pounds of coal per boiler horsepower per hour, the coal consumption will be in the neighborhood of 55,000,000 tons. Both the above estimates tend to belittle the coal consumption.

The Diamond soot blower will save 4 per cent, and often 8 per cent, of the fuel burnt by preventing the adherence of soot upon the heating surfaces, which for the above coal consumption represents a saving of 2,200,000 tons of coal annually when figured on 4 per cent basis. Expressed in dollars this represents a financial saving in the fuel bill of between $8,000,000 to $9,000,000. With normal loading railroad congestion and car shortage have been reduced to the extent of 44,000 carloads of coal.

A PORTABLE LIGHT RECORD

What is undoubtedly the largest contract for lights ever made in this country—and probably in the world—was closed lately when the Alexander Milburn Company of Baltimore received an order from the United States Government for portable lights representing the almost staggering total of more than 50,000,000 candlepower. They are intended for use in France, where they will play an important part in the feats of engineering behind the lines. Free communication between the front line and the bases—facile transportation, by rail, motor and wheel—is absolutely vital. The work of keeping these lines open is carried on day and night by means of these lights. These lights are of the portable car-

bide kind, such as the company has specialized for many years, and which the Government has standardized for army and navy uses. They use ordinary commercial carbide, a fuel sold throughout the world and obtainable in any quantity. It is safer than oil or gasoline and is readily handled.

RECENT DEVELOPMENTS IN AIR-PUMP DESIGN

BY E. P. JONES*

With the earliest types of surface-condensing equipment it was usual to employ one pump for removing both the condensate and air from the condenser. This pump was known as a "wet" air pump, and a good example of this type is the Edwards air pump, one of the most efficient of its class. The chief advantages of this type of pump are: (1) Low power required for driving; (2) positive action and consequent stability; (3) ability to cope with excessive air leakages. While the Edwards pump is still an excellent pump for units up to, say, from 3000 to 4000 kw., it must be remembered that, with the ever-growing size of power units, its disadvantages should be kept in view. For large units with Edwards pumps it is necessary that they should run at a very low speed, and consequently they are very cumbersome and take up a large amount of floor space.

With jet plants the Edwards pump is sometimes used as a dry air pump. It is necessary, of course, to provide a small quantity of water for sealing purposes. Volumetric efficiency in this pump varies considerably with the degree of vacuum required and decreases as the vacuum increases from about 50 per cent. at 3½ in. absolute pressure to 18 per cent. at 1 in. absolute pressure. Another system is that in which a dry air pump of the reciprocating type is used to remove the air and uncondensed gases and a separate pump to remove the condensate. The advantages and disadvantages of this system are the same as for the Edwards air pump, but the efficiency is rather better.

Previous to the introduction of the steam turbine condensing-plant equipments were furnished with air pumps of one or other of the types mentioned, but as soon as the turbine became a commercial proposition it was necessary to look for a type of pump having features specially adapted to its requirements. With turbine installations it is essential to use a high vacuum in the condenser, whereas with steam engines of the reciprocating type a vacuum of more than 26½ in. was seldom required. In fact, it is questionable whether using a vacuum higher than 26½ in. would not be considered a disadvantage. With the turbine, however, a vacuum less than 27 in. is rarely asked for, and sometimes the specified figure is as high as 29.25 in. with the standard barometer reading of 30 in. In considering these figures, due allowance must be made for the altitude of the place. The most economical vacuum for a turbine installation depends on a variety of things, and each case has to be considered on its merits.

On reference to steam tables it will be seen that an increase in vacuum from 27 in. to, say, 29 in., other conditions, as air leakage, remaining the same, necessitates an increase in the capacity of the air pumps from 1.00 to 3.25, which for a large installation with Edwards or reciprocating dry air pumps is a very serious matter. Therefore various types of rotary pumps, which are specially suitable for dealing with large volumes of air at low tension, have been designed since the adoption of the steam turbine, several of which have proved very successful. The general design of these pumps is much the same, in so far as they use a certain quantity of what is termed "operating water," for which various devices have been invented to cause this water to move in such a manner as to entrain the air from the condenser and discharge it to the atmosphere. Perhaps one of the best-known rotary dry air pumps is the one invented by Prof. Maurice Leblanc. It has been used to a large extent all over the world, and its action is shown by Fig. 1. This pump is capable of maintaining a very high vacuum, and for this reason, coupled with the fact that it is very simple in construction and not likely to get out of order, it has been largely used for turbine installations. It cannot be claimed for this pump—or, indeed, for any type of rotary air pump—that it can successfully deal with an excessive air leakage, but consideration will show that this quality is not essential in the case of turbine installations where air leakage is reduced to a minimum by the adoption of steam- or water-sealed glands where the shaft passes out of the turbine casing. With a sur-

*Institution of Engineers and Shipbuilders, Scotland.

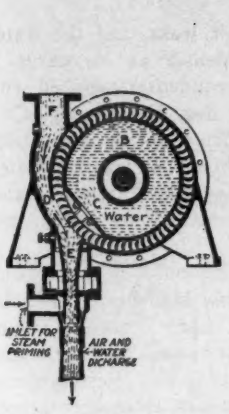


FIG. 1

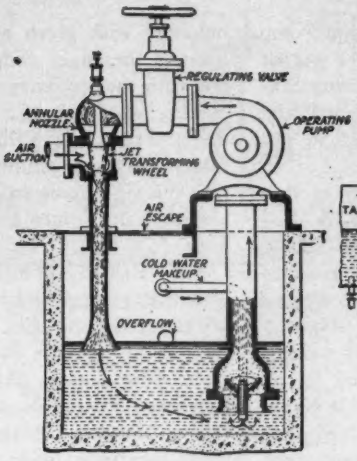


FIG. 2

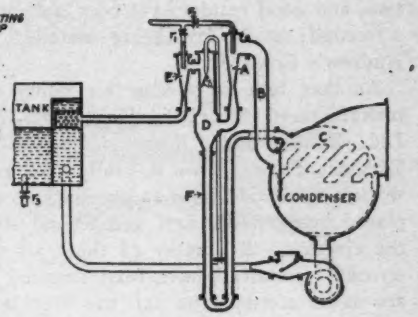


FIG. 3

LEBLANC AIR PUMP WORTHINGTON AIR PUMP EJECTAIR AIR PUMP

face-condensing plant it is only possible for air to be brought into the system by the feed water and carried over with the steam, or by leaking in at the joints. With jet plants, the air brought in with the injection water has to be allowed for in addition to the above, and it is for this reason that the air pump on a jet-plant requires to be larger than that for a surface-condensing plant doing the same steam duty.

The power required to drive these pumps is rather higher than that required for an Edwards or other good type of reciprocating air pump, and consequently a good deal of attention has been paid recently to another type of pump which would incorporate the simplicity of compactness of the rotary pump and the low-power consumption of the Edwards and other reciprocating pumps. The general trend of thought seems to have been in one direction, and there are now on the market and in commercial use air pumps operating on the ejector principle. Nearly all the leading condenser manufacturers now construct air pumps of this description.

THE NEW EJECTOR AIR PUMP

The Worthington Pump Co., Ltd., London and Newark, manufacture a patent hydraulic vacuum pump on the ejector principle, as illustrated by Fig. 2, which consists of: (1) The injection head, (2) the air-suction chamber, (3) the rotary wheel, (4) the throat and tail pipes. The operating water passes between two nozzle rings, and the cone of water passes between the body of the wheel and the outer sleeve, impinging on the inclined surfaces of the vanes, thus imparting a rotary motion to the wheel. To operate the pump it is necessary to provide a certain amount of sealing water, which is supplied from a tank situated as conveniently as possible to the pump. The sealing water takes up a certain amount of heat from the air and water vapors withdrawn by the air pump, and a piping arrangement is provided for withdrawing a certain amount of this water by means of a bypass connection on the operating pump discharge, this bypass being fitted with a controlling reflux valve. The quantity of water withdrawn in this manner is replaced by make-up water drawn from the circulating inlet-piping or an independent supply, thus cooling the water used in the cycle of operation. This apparatus is doing regular service on one of the turbo-alternator groups at the Glasgow Corporation Power Station at St. Andrew's Cross. A number of installations have also been supplied to other concerns.

Willans & Robinson, of Rugby, manufacture the Willans-Muller ejector air pump, which is operated by the circulating water, either on the series or shunt system. With the series system the whole of the circulating water passes through the ejector before entering the condenser. With the shunt system only a portion of the cooling water passes through the ejector, and, after use, is returned to the pump suction or the source of supply. A third method of operating this ejector is by the separate-pump system, in exactly the same manner as described in referring to the Worthington pump. The whole plant is very

similar to that made by the Worthington Pump Co. The Glasgow Corporation has a set of this apparatus at work at Pinkston Power Station, and good results have been obtained, and a second set is just being installed at St. Andrew's Cross.

Another type of ejector air pump is that manufactured by Hick, Hargreaves & Co., Ltd., Bolton, under license from the Mason Breguet, Paris. This is really two ejectors working in series, with an auxiliary condenser placed between the first and second stage of the ejectors. A number of these air pumps, termed "ejectairs," have been supplied to, or are under construction for, the French Navy. Referring to Fig. 3, it will be observed that the primary ejector *A* is placed in direct communication with the main condenser *C*, and extracts the aërated vapor, being operated by a single steam jet or nozzle r_1. The mixture of steam and partly compressed vapor is then discharged to the auxiliary condenser *D*, and the water returned to the main condenser to be dealt with by the extraction pump. The second-stage ejector *E* is coupled up to the auxiliary condenser, and draws the air away, discharging it to the feed tank. An automatic air-inlet valve is fitted to the auxiliary condenser, to regulate the absolute pressure therein. It is claimed that taking air from the atmosphere in this manner materially assists the stability of the plant, and also renders it more flexible. These *ejectairs* are designed for working with steam pressures at 55 lb. per sq. in. or above, and with a special arrangement of nozzles lower pressures can be used in the primary ejector, although the advantage of this is not apparent if it is impossible to work the other ejector under the same conditions, neither is it clear whether this can be accomplished or not.

The curves, Fig. 4, show the performance of an *ejectair*. Steam to the ejectors had an absolute pressure of 125 lb. per sq. in., and the steam consumption is given as 194 lb. per hour, of which 129 lb. is recoverable. The apparatus worked in conjunction with a small jet condenser, dealing with 94 gal. of injection water per minute. Curve 1 gives the vacuums obtained with water leaving the condenser at a temperature of 91.4 deg. F. (33 deg. C.), and the auxiliary condenser out of action; curve 2 the volume of air dealt with in cubic feet per hour; curve 3 the vacuums obtained with given air leaks, and the water leaving the main condenser as for curve 1, but with the auxiliary condenser supplied with cooling water at 66.2 deg. F. (18 deg. C.); and curve 4 the volumes of air dealt with under the same conditions. It was calculated that the air coming in with the injection water and at leaky joints amounted to 1.102 lb. per hour (0.5 kg.).

The British Westinghouse Electric and Manufacturing Co., Ltd., Manchester, and the Mirrlees Watson Co., Ltd., Glasgow, manufacture an ejector air pump under license from the Société Anonyme Westinghouse, Paris and Le Havre, which is another invention of Maurcie Leblanc. It is the outcome of many months of arduous research work, during which time innumerable difficulties were surmounted by the inventor, with the result that a really first-class ejector air pump has been evolved. Figs. 5 and 6 show the general arrangement of this apparatus. It will be noticed that the pump is arranged to work in two stages, and the steam is admitted to the second stage of the ejector by opening the stop valve *C*. Immediately *C* is opened, steam fills the annular space behind the nozzle plate, and finds its way into the throats of the group of nozzles *Y* attached to this plate; it then passes along the steam pipe which supplies the first-stage nozzles *X*, which are also attached to a nozzle plate. The supply of steam in this set of nozzles is controlled by the stop valve on the steam-supply pipe. The pump is connected to the condenser at the branch *D*, which is the air-inlet branch. At the entrance to each of the steam spaces fine wire-gauze strainers are

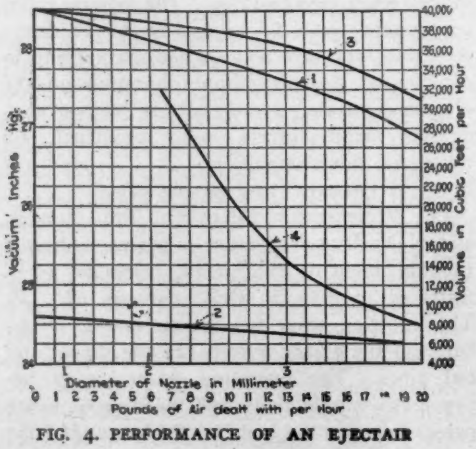


FIG. 4. PERFORMANCE OF AN EJECTAIR

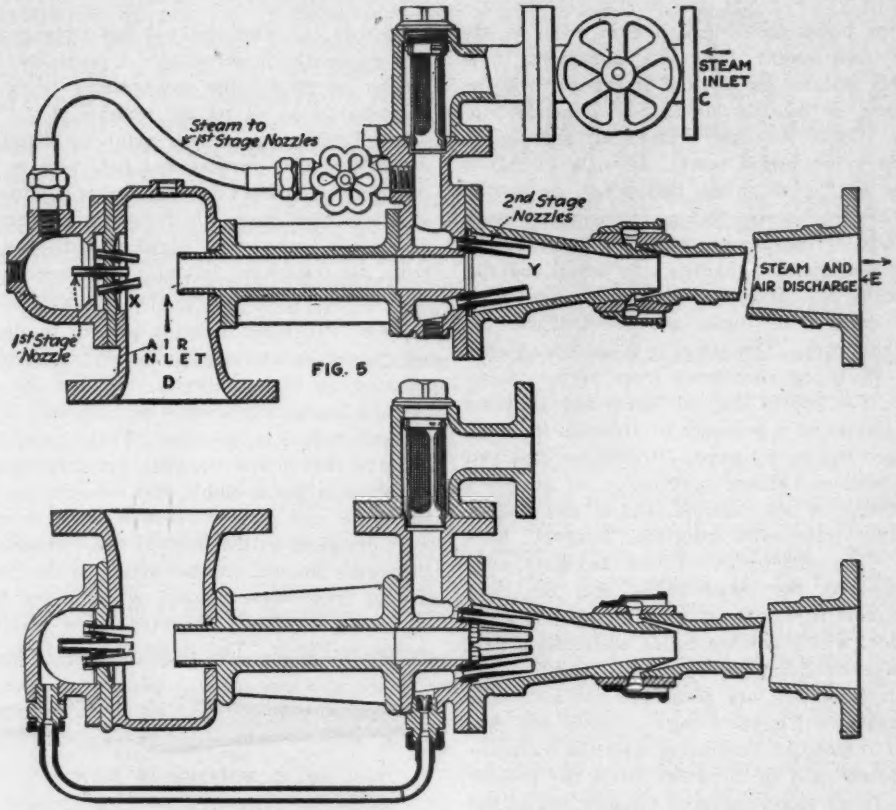


FIG. 5

FIG. 6

TWO FORMS OF LEBLANC EJECTOR

fitted to prevent any foreign matter, which may have primed over with the steam from the boilers, from entering the nozzles, thereby intercepting any stoppage in the nozzle throats, and consequently a loss of vacuum. These nozzles are securely locked to the nozzle plates. The mixture of air and steam is discharged at the mouth of the cone *Y* and led away to the boiler-feed tank, so that the heat units contained in the operating steam can be reclaimed by heating the feed water. To start the pump to work, it is only necessary to open up the steam valve *C*, and the vacuum will at once begin to increase in the condenser or other vessel to be evacuated. When the vacuum gage becomes stationary, the first-stage steam-inlet valve is opened up to bring the vacuum to a maximum. A very important feature in this pump is the absence of moving parts. The simplicity of the apparatus is even more remarkable than that of the Leblanc rotary pump.

The advantages claimed are as follows: (1) Extreme simplicity; (2) the small amount of energy required for operating purposes; (3) the high efficiency obtained; (4) ease with which starting can be effected, and the small amount of attention required while at work; (5) ability to produce the highest possible vacuums; (6) stability. In scanning these claims we can pass over the first, which as already mentioned, is obvious; there are simply two steam valves to open. The second deserves some consideration. The operating steam in passing through the nozzles decreases in pressure, and consequently in temperature, and also, after passing through the nozzles, does work in accelerating the velocity of the air, increasing its temperature and compressing it. There is also a small amount of heat lost due to friction in passing through the diffuser portion of the ejector, which might be considered negligible. Beyond this, the whole of the heat in the steam can be utilized to heat

up the boiler-feed water, and in order to obtain full benefit from the apparatus it is highly desirable to use the discharge from the ejector for heating purposes of some description. Thus both the steam and air can be made to do useful work. In view of this it must not be forgotten that when an ejector of this type is specified as requiring so many pounds of operating steam per hour, this is only the apparent quantity; the actual quantity is really far less, since the great majority of heat units in the steam are still available for further work. The actual heat units recovered can easily be calculated from steam tables, since it is known that the steam and air leave the ejector at a pressure of from 10 lb. to 12 lb. per sq. in. by gage. It will be observed that with a Leblanc multijector an auxiliary condenser is not required, and in this respect it differs materially from the "Berguet" *ejectair*. The employment of an auxiliary condenser has the disadvantage that the total heat units of the steam used in the first-stage ejector, which amount to an appreciable percentage of the total heat units used on the whole apparatus, are dissipated and lost. The makers give this percentage as about 33. Another reason for dispensing with the auxiliary condenser will be apparent from the following. In all steam-operated ejectors one of the difficulties that have to be contended with is the fact that the steam leaves the nozzles at a velocity varying from about 3,000 to 3,600 ft. per sec., while the velocity of the fluid to be entrained is practically nil. This is the cause of considerable loss of efficiency in any ejector, but if an auxiliary condenser be used the defect is doubled, because the velocity of the fluid to be entrained, which has been imparted to it by the operating steam during its passage through the first-stage ejector, is dissipated and lost as soon as it enters the condenser. The cooling water used on the auxiliary condenser has to be dealt with by the condensate pump, thus increasing the power absorbed by the plant. When working with surface condensers, this water must be of good quality, as it has to be returned to the boilers.

The third claim relates to efficiency. It is well known that ordinary single-stage ejectors only work well when the compression ratio is as 1:7, and it is partly for this reason that the Breguet Co. has introduced the auxiliary condenser, so that the vacuum obtaining in this condenser is about 25.6 in. with the barometer at 30 in., the compression being approximately as 11:76, or, roughly, 1:7. The over-all efficiency of this plant is, therefore, apparently still further reduced, because air is admitted from the atmosphere into the auxiliary condenser, which is under a vacuum of 25.6 in., and this, together with the air from the condenser, has also to be ejected by the secondary ejector to the atmosphere.

When Professor Leblanc set out to design his ejector he foresaw the possibility of using an intermediate condenser, but he also appreciated its disadvantages and decided to do without it if at all possible. At the same time he knew that it was essential to use two stages in order to get a stable and efficient ejector. With this end in view, certain steam nozzles were designed on the lines of the formulas of Professor Rateau, and the action of the steam issuing from these nozzles when under high vacuum was directly observed. The result is shown by Fig. 7. The steam issuing from the

FIG. 7. BEHAVIOR OF FLOW

mouth of the nozzle expands and contracts alternately, ultimately assuming a section of constant area. It was found that a number of these nozzles grouped together gave far better results than a single nozzle of the same throat area as the group of nozzles. The reason for this is to a large extent due to the fact that the alternate increasing and decreasing of the cross-sectional area of the steam stream is minimized by the contact of one steam stream with the next, when groups of nozzles are employed, and this helps considerably to increase the surface available for the entertainment of the air and gases. This entrainment is carried on mainly by friction, and it will be seen that if an appreciable amount of gas has to be dealt with, the frictional surface exposed to the gas has to be as large as possible. It is also inversely proportional to the density of the gas or fluid.

The number and size of the nozzles depends entirely on the space available in the diffuser, and keeping within the limits of workshop practice. The smallest number employed by

the Mirrlees Watson Co. is three, each of which has a throat diameter of 1 mm. These are first-stage nozzles. On the largest size of pump, and in the second stage, the number of nozzles is 30, and these have a throat diameter of 5.2 mm. when using operating steam at 90 lb. per square inch.

Professor Leblanc, in his paper of 1911 to L'Association Technique Maritime, says that "the operating steam entrains the air by friction. During entrainment it is the velocity of the steam which is utilized, and not its kinetic energy."

Calling M the weight of operating steam used per second, V its velocity at the outlet of the nozzles, m the weight of air drawn in per second, and W the velocity of the mixture of air and steam, then

$$MV = (M + m)\,W$$

The ratio of the kinetic energy, $\frac{mW^2}{2}$, of the air drawn in to the kinetic energy, $\frac{MV^2}{2}$, contained in the operating steam as it comes out of the nozzles can therefore be stated as

$$\frac{mW^2}{MV_1^2} = \frac{mM}{(M+m)^2}$$

so that when $\frac{m}{M} =$ 1 ½ ⅓ ¼ ⅕

$$\frac{mM}{(M+m)^2} = 0.25,\ 0.222,\ 0.187,\ 0.160,\ 0.139$$

This shows that if the utilization of the kinetic energy is to be the basis of the design, then for maximum efficiency it is necessary to bring the ratio $\frac{\text{air dealt with}}{\text{operating steam used}}$ as near to unity as possible.

M. Leblanc continues: "We tried to diminish the loss of kinetic energy by producing at the entrance of the diffuser a higher vacuum than was necessary, so that the fluid drawn in came in contact with the operating steam with a considerable velocity. If the efficiency of the diffuser could be brought almost to unity, we could add considerably to the over-all efficiency, but this has been found to be impracticable. Following on this, it was suggested to use puffs of steam after the manner of steam coming out of locomotive chimneys, but the complications involved in making arrangements for stopping the inlet of air during each puff were such that it would have been easier to use a centrifugal compressor. Afterward we tried to compensate for the bad efficiency due to frictional entrainment by transforming heat into kinetic energy in the nozzles. Superheating the operating steam, although so useful for turbine work, is, however, not good for an ejector, because it is more difficult to effect compression in the diffuser, which outweighs the advantages obtained in the nozzles. The next scheme was to use hot water in the nozzles, but this also proved unsuccessful."

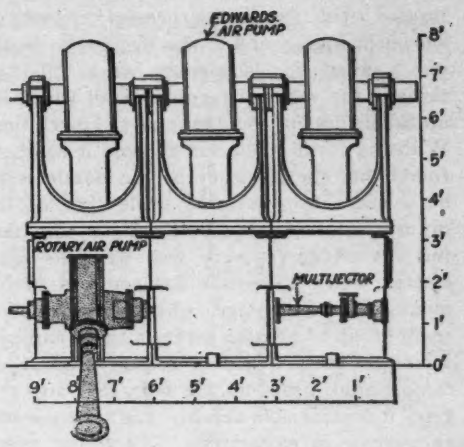


FIG. 8. COMPARATIVE SIZES

After numerous other trials it was decided that entrainment by friction was most economical, and various types of diffusers and different groupings of nozzles were experi-

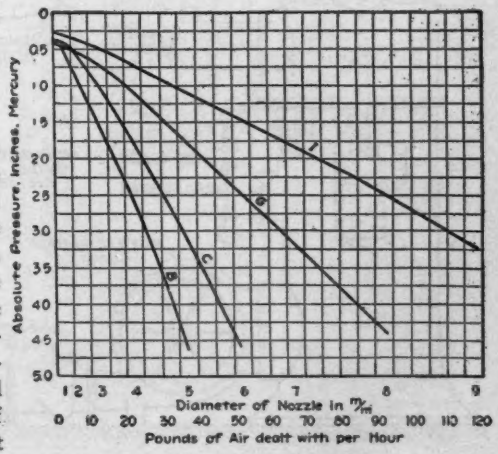


FIG. 9. CAPACITIES

mented with, until the present ejector, as shown in Figs. 5 and 6, was decided to be the most suited for condenser work. To go through the various stages in detail which led up to this design would take up too much time. With the form of ejector adopted it has been found that the efficiency of the nozzle is on an average 85 per cent., while that of the diffuser is 70 per cent. It will be seen that this ejector agrees very well with the ideal ejector which Professor Leblanc had in his mind. The first stage, which consists of a small group of nozzles, serves a triple purpose, inasmuch as it effects a certain amount of compression, heats up the entrained air, and gives it considerable velocity, and consequently an increase in momentum. The second stage has a large number of nozzles, and it is here where the major portion of the work is done, the air being compressed from approximately 26 in. vacuum up to something more than atmospheric pressure. To be more accurate, the steam used in the first stage is about 5 per cent. of the total.

In support of the fourth advantage which this air pump is supposed to possess, the following figures were obtained on the French torpedo-destroyer "Boutefeu." The turbines were stopped, but steam was on the glands. The volume to be evacuated was about 635 cu. ft. After 1 min. the vacuum was 6 5-16 in., 2 min. 15 in., 3 min. 22 13-16 in., 4 min. 25 9-16 in., 5 min. 26¾ in., and 6 min. 27 9-16 in. The theoretical vacuum corresponding to the tem-

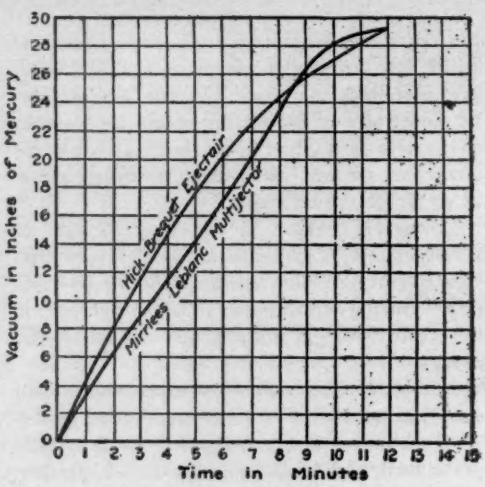


FIG. 10. TIMES REQUIRED FOR STARTING

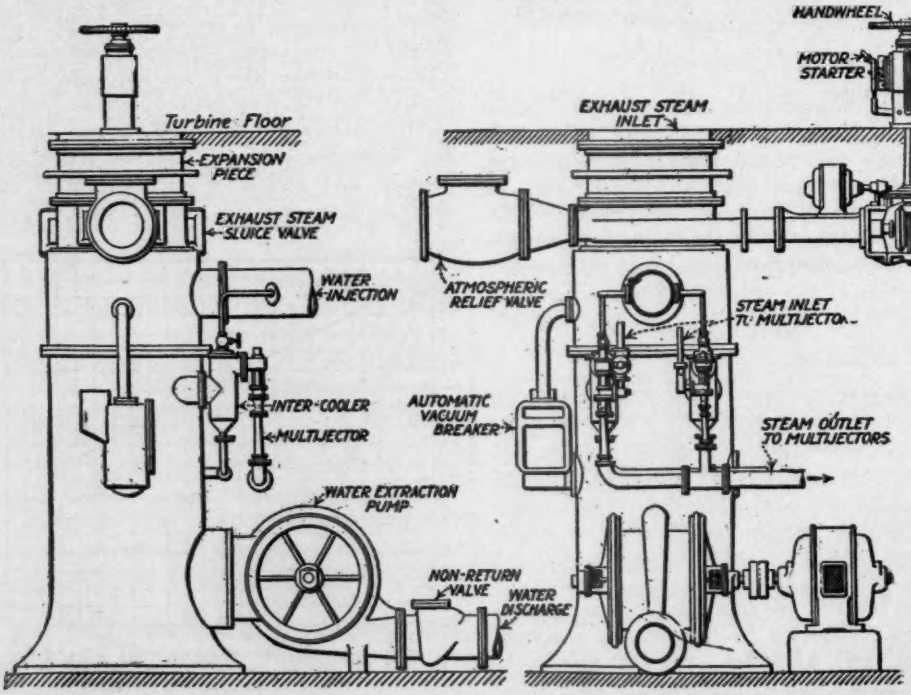


FIG. 11. MULTIJECTORS AT SCOTTISH CENTRAL POWER CO.

perature of the water, 67.1 deg. F.; namely, 28¼ in., was attained in 11 min. It was also arranged later to allow certain known air leakages to enter the condenser. With a 5-mm. nozzle, which passes 36.2 lb. of free air per hour, the vacuum dropped only ⅜ in. With a 15-mm. nozzle, which is equivalent to 326 lb. of air per hour, the vacuum was 21¼ in. With an inch cock full open it took 11 min. for the vacuum to fall to 12¼ in., at which figure the mercury column remained steady. On closing the regulating valve below the nozzle, the vacuum at once rose and attained the maximum almost immediately. There is a central station near Glasgow where this type of apparatus is at work with a multijet condenser. Sometimes when changing machines there is liability partially to lose the water for a minute or so, but none of the staff ever have to trouble about the ejectors, and as soon as the water comes back again the vacuum at once builds up, and the set is never shut down through failure of the air pumps. As a matter of fact, in the case above stated, it is highly probable that during the period that the water supply to the condenser is very small there is an air passage between the water spaces of the other condensers in the station and the multijet plant which would allow of a very excessive quantity of air getting into the condenser on load. This also shows that stability, the sixth claim, is another salient point. That high vacuum can be obtained is proved by the fact that this apparatus is now being used in the French Navy and mercantile marine, as well as on some land installations for refrigerating purposes, and installations are at work where the maximum vacuum obtained is within 1 mm. of the barometer. For condensers the best results yet obtained by the French Westinghouse company are within 5mm. of the barometer.

From the foregoing it would appear that this type of air pump is ideal for use on board ship, and particularly in the navy, where space is so valuable and weight of such consideration, and to illustrate this point Fig. 8 has been produced, and represents to the same scale an Edwards air pump, Leblanc rotary air pump, and Leblanc multijector for a steam duty on a surface condenser of 40,000 lb. per hour, water at 60 deg. F., vacuum 28½ in., and barometer 30 in. The weights are approximately 20, 832 lb., 4,480 lb., and 97 lb., respectively. For land work it is equally suitable, and will soon supersede the rotary pump in

OFFICIAL TEST OF NO. 18 M. J. CONDENSING PLANT WITH MOTOR-DRIVEN WATER-EXTRACTING PUMP, 1-SIZE "G" AND 1-SIZE "I" MULTIJECTOR AIR PUMP INSTALLED AT THE SCOTTISH CENTRAL ELECTRIC POWER COMPANY, LIMITED, BONNYBRIDGE

Duty—50,000 lb. steam per hour.
Vacuum—28.5 in. (barometer 30 in.).
Injection water—3,800 gallons per minute, temperature 65 deg. F.
Air pump capacity—84 lb. air per hour with guaranteed vacuum and water temperature.
Large ejector to operate condenser alone on loads over one-third and up to two-thirds full load.
Small ejector to work alone on loads of one-third full load and under.
Both ejectors to work on loads over two-thirds full load.

	Load			— Vacuum —		Baro-	Steam Press. on Ejectors		Steam Press. on Turbine	Injection Water		——Extraction Pump——			
	Volts	Amps.	P.F.	Kw.	Turbo.	Condr.	meter	"G"	"I"	Inlet	Outlet.	Press, Gage	Amps.	Volts	R.P.M.
8.45 p.m.	6,350	130	0.75	1,070	28.1	28.2	29.8	120	Shut off	152		5	58/60	440	480
11.0 a.m.	6,350	266	0.7	2,000	28.5	28.5	29.66	122	130	152	43	70.0	60	440	480
12.0 m.	6,350	280	0.7	2,152	28.6	28.5	29.63	122	125	152	43	70.0	59	440	480
12.5 p.m.	6,400	270	0.7	2,090		28.2	29.63	Shut	125	152	43	70.0	59	440	480
1.15 p.m.	6,400	325	0.75	2,700	28.2	28.25	29.59	125	160	150	43	72.5	62½	440	480
2.45 p.m.	6,450	345	0.76	2,970	28.2	28.3	29.59	125	157	157	43	72.5	62½	440	480
3.0 p.m.	6,500	280	0.74	2,330	28.2	28.4	29.6	122½	160	153	43	65.5	62½	440	480
3.30 p.m.	6,500	230	0.7	1,182	28.5	28.5	29.6	120	150	154	43	65.5	23	440	480

TESTS AT SCOTTISH CENTRAL

many power stations. For sugar refineries, chemical and other allied works it should prove exceptionally attractive and take the place of many reciprocating dry air pumps.

It may be advisable to point out here that this pump is purely a dry air pump, so that for surface condensers an additional water or condensate pump is still required, and for jet plants the usual extraction pump.

Fig. 9 shows the air-dealing capacity of various sizes of multijector pumps taken from the actual tests. The maximum vacuum in each case is equivalent to the theoretical, the slight difference at the origin of the curves being due to the different test conditions.

The table of tests, I, is taken from a plant installed at the Scottish Central Power Station at Bonnybridge at a date six months after the plant was put on commercial load. This company has just decided to order another plant, and has specified Mirrlees-Leblanc multijector air pumps.

Fig. 10 shows the time taken to start up a Hick-Breguet *ejectair* and a Mirrlees-Leblanc multijector.

Fig. 11 shows installation of multijector air pumps at Scottish Central Electric Power Co., Bonnybridge.

DISPLACEMENT TANKS FOR METERING COMPRESSED AIR

BY WALTER S. WEEKS

The following, which has originally appeared in *Mining Press*, describes an arrangement not essentially new, it having been shown in Compressed Air Magazine, August, 1912. It appears here with improvements in detail, and the description also will be found more practical and specific.

The general principle of displacement-tanks for measuring the air-consumption of rock-drills is known to most engineers, but it takes a good deal of experimenting to construct them so that they will work properly. It is hoped that these few suggestions will be helpful.

The elements of the displacement-tanks are two closed tanks connected with a pipe at the base and equipped with valves so that air may enter one while leaving the other. The air in the two tanks is always separated by a piston of water, which flows back and forth from one tank to the other. The change in level of the water in one tank multiplied by the area of the tank is the volume of air that has flowed out.

It will occur at once to the reader that there are two possible ways of measuring the volume of air displaced. In the first method we place on one tank a gauge-glass that reaches from the top to the bottom. We can read the gauge-glass at the start and after a given elapsed time, say, a minute, read it again. From these readings we can compute the flow of air per minute. The main drawback to this method is that the tanks must be perfectly regular from top to bottom, or else the volume must be calibrated in many places.

In the second method we place two small gauge-glasses on one tank, one at the top and one at the bottom, and find the volume between two marks on the glasses. If we take the time for the water to rise from the lower mark to the higher with a stop-watch, the volume flowing per minute can be calculated. With this type of meter, tanks of any shape can be used.

The air entering the tanks must do so at constant pressure. A reducing-valve is needed. I have tried many kinds and the most satisfactory one is comparatively inexpensive. It is made by the Westinghouse Air Brake Co. and is known as the S 4 locomotive governor. The price is $21. It should be fitted with a hand-wheel so that it may be regulated easily. It should be arranged as shown in Fig. 1 (*a*). (All references will be to Fig. 1 unless otherwise specified.) The control-pipe *b* should not be connected to a tank because the valve continuously exhausts air to the atmosphere. A lubricator *r* should be placed on the control air-line feeding very thin oil to the valve.

The air, after passing the reducing-valve, must enter first one tank and then the other and when it is entering one it must be leaving the other. These operations require a four-way valve. The stock four-way valve is costly and generally leaks. An excellent four-way valve can be made with four single valves *c* arranged as shown, with levers, so that they can all be thrown together. The valves are made by the Westinghouse company and are known as 1-inch cut-out valves. They cost $1.80 each. In the pipe *d* connecting the tanks at the bottom should be placed a quick-closing gate-valve *e*. It is necessary to measure the volume of but one tank. Glancing at Fig. 1, place a mark on the gauge-glass *f* and fill with

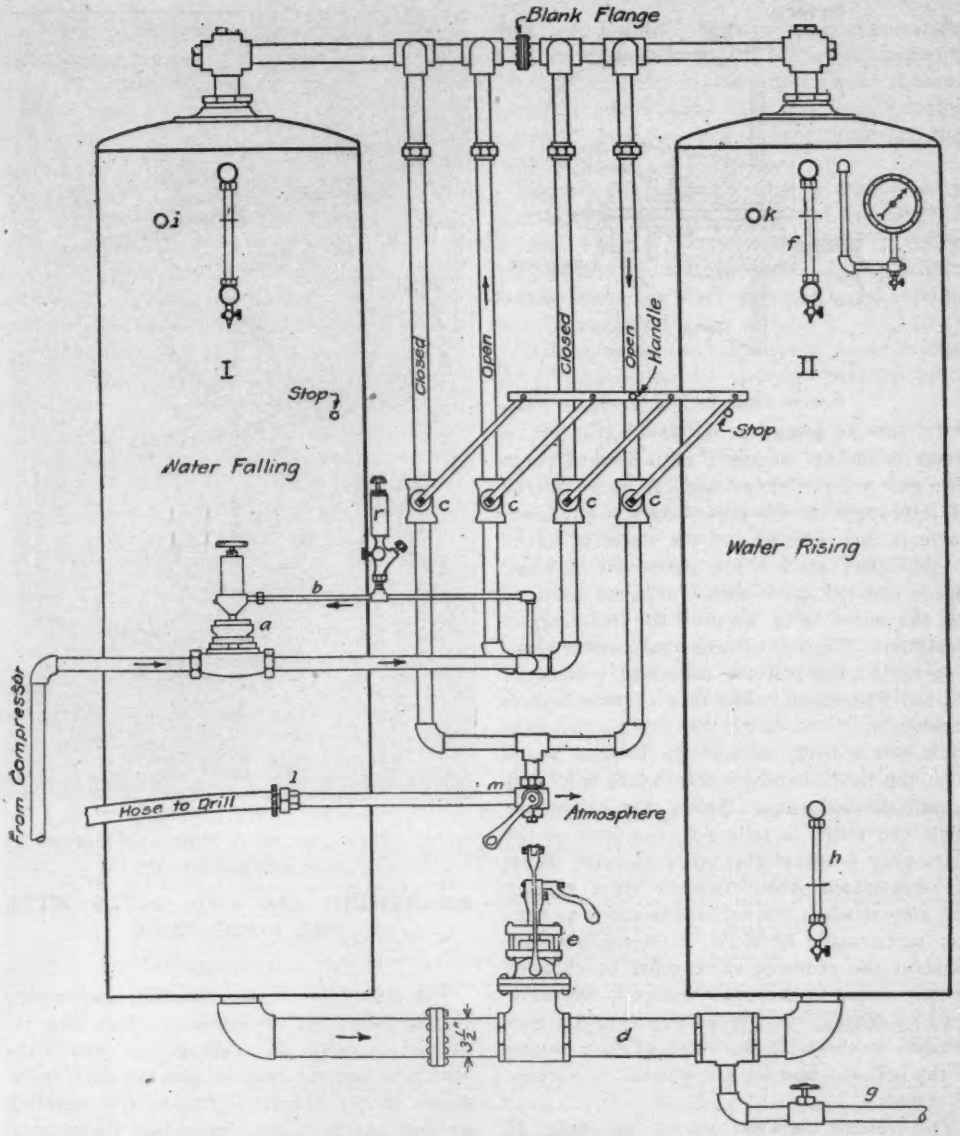


FIG. I

water to that point through the pipe *g*. Close the gate-valve. Draw off water through the pipe *g*, carefully measuring it until it comes in sight on the glass *h*. Now draw carefully until an even number of cubic feet is reached and mark point on the glass *h*. When the water in tank II rises from the lower mark to the higher, the measured volume of air has been displaced.

To obviate the necessity for watching the gauge-glasses I have arranged for a bell to ring at the two critical points. It is done by fitting up spark-plugs so that a contact is made between the tank and the sparking point of the plug by means of a float. The principle is shown in Fig. 2. An ordinary automobile-plug fitted with a float is tapped in at *i*. A plug built as shown in the drawing is placed at *k*. The plug is so constructed that the point of ringing can be controlled by screwing the centre point in or out. The plug *k* is placed on a line with the mark on the gauge-glass. A water-glass should be placed opposite the plug *i*, as shown.

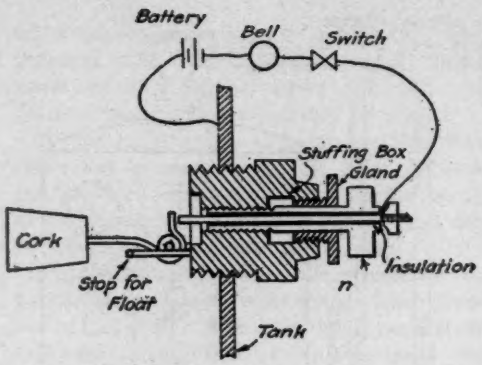


FIG. 2

To put the apparatus in working order the water is run up in tank I until the bell rings. The gate-valve is closed and the water in tank II is brought to the lower mark. The gate-valve is then opened and the water is forced to the upper mark. The gate-valve is again closed and the spark-plug *k* adjusted by turning the nut *n* (Fig. 2) until the bell rings at this point. Thus it is seen that between two ringings of the bell the measured volume of air has flowed out. The time is taken with a stop-watch.

To test a drill, connect the hose at 1 and start the drill running. Run water into tank I until the bell rings. Throw the valves and while the water is falling to the level of the spark-plug *i* adjust the reducing-valve. Start the stop-watch when the bell stops ringing and stop it when the bell starts again by contact being made at *k*. To hold the pressure constant the reducing-valve must be changed slightly owing to the small change in hydraulic head on the air. A run of any duration may be made by throwing the valves at each ringing of the bell and keeping account of the number of throws.

The volume between marks on tank II should be about 16 or 18 cu. ft. for ordinary drill-testing. Means should be provided to exhaust the air in the tanks to the atmospheric pressure if necessary. In the tanks shown in the drawing it is accomplished by a three-way valve at *m*. Charts may be plotted for different gauge-pressures with time in seconds between bells, against free air per minute.

The demand for gas in New York city is running 23,000,000 cu. ft. in excess of a normal day's consumption in other years.

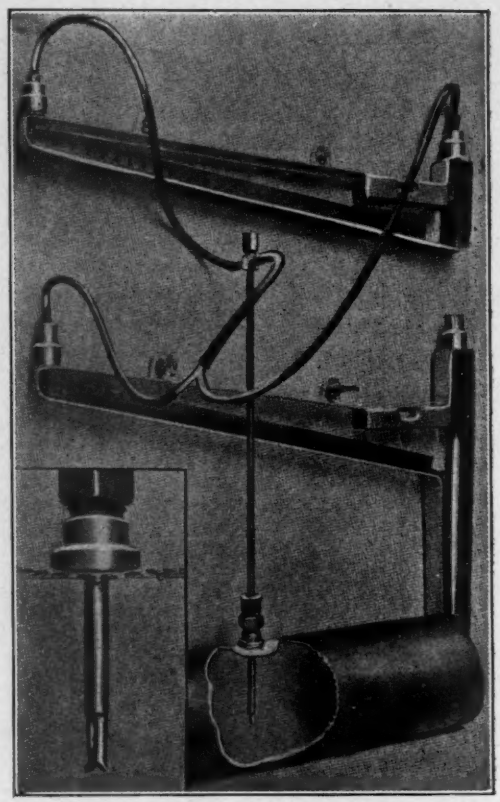


FIG. 1. DETAIL OF PITOT TUBE AND METHOD OF ATTACHMENT TO PIPE

MEASURING AIR AND GASES WITH THE PITOT TUBE

BY A. H. ANDERSON*

The pitot tube is now generally understood by engineers, but its application has been restricted to research. Perhaps the reason the pitot tube has not received the attention it deserves in the industrial trades, for metering air and gas, is because recording instruments are available. Recording meters are desirable, but there is still a wide field in which an inexpensive device must be used. For instance, in distributing costs of gas or air among various departments, an indicating pitot tube may be placed in each branch and practically the same information obtained as with an elaborate instrument. In the air supply duct to a foundry cupola or a set of forges, the proper quantity

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of air can be gaged with a pitot tube and maintained during the period of operation.

The pitot tube is easily changed from place to place, and the pressure or velocity of air may be gaged at different points along an exhaust line where the size of duct changes with the number of branches admitted.

The indications of the pitot tube are made readily available by the use of the tables given in this article by means of which calculations are avoided. They apply to air at approximately atmospheric pressures and also to gases of various densities, such as illuminating, coke oven, blast furnace and natural gas. In order that these tables may be applied directly, the coefficient of the pitot tube must be 1.00. If the coefficient of the pitot tube is 0.8, then the tabular value for velocity must be multiplied by 0.8. The pitot tube in Fig. 1 has a coefficient of 1.00.

An illustration of the proper method of connecting a pitot tube to the indicating differential gages is shown in Fig. 1. The liquid used in the gages is a mineral oil of 0.834 specific gravity and the color is red to make it conspicuous. The scale attached to the gage is graduated to read in inches of water. The dynamic (or bent) tube is in communication with the left-hand end of the upper gage. The static (or beveled) tube is in communication with the right-hand end of the lower gage. Therefore, the upper gage indicates the "velocity pressure" and the lower gage indicates the static pressure.

The velocity corresponding to the "velocity pressure" may now be determined by reference to the tables. Temperature, static pressure and humidity affect the velocity, but within certain limits the static pressure and humidity may be neglected.

Table I, shows the velocities of air at 80 deg. F., corresponding to various "velocity pressure" readings, in inches of water.

Table II, shows the coefficient by which the velocities in Table I may be multiplied when the air is of any other temperature than 80 deg. F. Coefficients are also given in this table for gases of various densities.

In certain cases where the pitot tube is placed in a long straight pipe, it may be assumed eddy currents are absent, and the tip of the pitot tube may be located at a distance from the center equal to 0.8 of the actual radius, in order to obtain average results. In most cases there are conditions which deflect the air currents in the pipe, and the maximum velocity is found at one side of the center. Un-

TABLE I. AIR VELOCITIES CORRESPONDING TO VARIOUS VELOCITY PRESSURE READINGS

Air at 80 deg. fah.; 100% humidity; 29.5 in. Barometer.

Vel. Press. Inches.	Ft. per min.	Vel. press. inches	Ft. per min	Vel. press. inches	Ft. per min	Vel. press inches	Ft. per min
.01	409	.50	2,890	.99	4,070	1.48	4,976
.02	579	.51	2,920	1.00	4,090	1.49	4,993
.03	710	.52	2,950	1.01	4,110	1.50	5,010
.04	818	.53	2,980	1.02	4,130	1.60	5,180
.05	914	.54	3,000	1.03	4,150	1.70	5,350
.06	1,000	.55	3,030	1.04	4,170	1.80	5,490
.07	1,080	.56	3,060	1.05	4,190	1.90	5,640
.08	1,155	.57	3,090	1.06	4,210	2.00	5,790
.09	1,227	.58	3,115	1.07	4,230	2.10	5,930
.10	1,295	.59	3,140	1.08	4,250	2.20	6,080
.11	1,355	.60	3,170	1.09	4,270	2.30	6,210
.12	1,418	.61	3,200	1.10	4,290	2.40	6,350
.13	1,475	.62	3,225	1.11	4,308	2.50	6,480
.14	1,530	.63	3,250	1.12	4,327	2.60	6,600
.15	1,585	.64	3,275	1.13	4,345	2.70	6,720
.16	1,635	.65	3,300	1.14	4,364	2.80	6,850
.17	1,690	.66	3,325	1.15	4,382	2.90	6,970
.18	1,735	.67	3,350	1.16	4,401	3.00	7,090
.19	1,785	.68	3,375	1.17	4,419	3.10	7,200
.20	1,830	.69	3,400	1.18	4,438	3.20	7,320
.21	1,875	.70	3,425	1.19	4,456	3.30	7,430
.22	1,920	.71	3,450	1.20	4,475	3.40	7,540
.23	1,960	.72	3,475	1.21	4,493	3.50	7,660
.24	2,005	.73	3,500	1.22	4,512	3.60	7,760
.25	2,040	.74	3,525	1.23	4,530	3.70	7,870
.26	2,090	.75	3,550	1.24	4,549	3.80	7,970
.27	2,125	.76	3,570	1.25	4,567	3.90	8,070
.28	2,160	.77	3,590	1.26	4,586	4.00	8,180
.29	2,200	.78	3,615	1.27	4,604	4.10	8,280
.30	2,240	.79	3,640	1.28	4,623	4.20	8,400
.31	2,275	.80	3,660	1.29	4,641	4.30	8,480
.32	2,310	.81	3,680	1.30	4,660	4.40	8,580
.33	2,350	.82	3,700	1.31	4,678	4.50	8,670
.34	2,380	.83	3,720	1.32	4,696	4.60	8,770
.35	2,420	.84	3,740	1.33	4,714	4.70	8,870
.36	2,455	.85	3,765	1.34	4,732	4.80	8,970
.37	2,485	.86	3,790	1.35	4,750	4.90	9,060
.38	2,520	.87	3,810	1.36	4,768	5.00	9,140
.39	2,550	.88	3,835	1.37	4,786		
.40	2,580	.89	3,860	1.38	4,804		
.41	2,620	.90	3,880	1.39	4,822		
.42	2,650	.91	3,905	1.40	4,840		
.43	2,680	.92	3,925	1.41	4,857		
.44	2,710	.93	3,946	1.42	4,874		
.45	2,740	.94	3,967	1.43	4,891		
.46	2,770	.95	3,988	1.44	4,908		
.47	2,800	.96	4,008	1.45	4,925		
.48	2,830	.97	4,029	1.46	4,942		
.49	2,856	.98	4,050	1.47	4,960		

TABLE II. VELOCITY COEFFICIENTS FOR VARIOUS TEMPERATURES

Deg. Fahr.	Air	G A S Lb. per cu. ft. at 80 deg. .05	.055	.06	.065
50	0.972	1.160	1.111	1.060	1.020
60	0.980	1.170	1.120	1.070	1.030
70	0.990	1.180	1.130	1.080	1.040
80	1.000	1.200	1.140	1.090	1.050
90	1.010	1.210	1.150	1.100	1.060
100	1.025	1.225	1.170	1.115	1.075
110	1.036	1.245	1.185	1.130	1.090
120	1.049	1.255	1.195	1.143	1.100
130	1.060	1.270	1.210	1.155	1.111

der these conditions, it is necessary for accurate results to determine the average velocity by making a traverse of the pipe with the pitot tube. This can be done in the following manner: Determine the actual radius of the round pipe and make a series of pitot tube observations at intervals from the center to the wall. The intervals between the readings are determined by the equation.

$$R = \frac{r}{\sqrt{N}} \sqrt{2a - 1}$$

Where R=distance of various positions from center of pipe, inches.
r=radius of pipe, inches.
N=number of readings desired from wall to wall.
a=order of readings from center.

The pitot tube is now located in turn at the positions as determined above, first, on one side of the center, and then on the other side. The velocities corresponding to the ten velocity pressures are taken from Table I, and the arithmetical average determined.

As an illustration, assume a round duct 10 in. diameter, the number of observations from wall to wall to be ten. In this case, "r"=5 in. "N"=10; "a" assumes values from 1 to 5. The values of "R" on one side of the center resulting from the substitution in the equation are as follows:

Distance from center, inches

R_1 ..... 1.58
R_2 ..... 2.73
R_3 ..... 3.53
R_4 ..... 4.18
R_5 ..... 4.74

TABLE III. RESULTS OF TEST OF A 10-IN. PIPE

Distance from wall, in.	Distance from center, in.	Velocity pressure, in.	Velocity ft. per min.
0.27	4.73	0.105	1310
0.83	4.17	0.125	1450
1.50	3.50	0.145	1550
2.27	2.73	0.160	1630
3.42	1.58	0.165	1650
6.58	1.58	0.165	1650
7.73	2.73	0.160	1630
8.50	3.50	0.145	1550
9.17	4.17	0.125	1450
9.73	4.73	0.105	1310
		AVERAGE	1550

The positions on the other side of the center are duplicates of those given below. Actual velocity pressures and velocities from a test of a 10-in. pipe are shown in Table III, the corresponding curve being given in Fig. 2.

The pitot tube may now be permanently located in the pipe in either of the two ways described:

(1) Locate the tip of the pitot tube at the proper distance from the center of the pipe to obtain average reading; or

(2) Locate the tip of the pitot tube at the center of the pipe and multiply the indicated velocity by the ratio of the average to the center velocity.

Method 1. Figure 2 gives a curve showing the variation of velocity across one diameter of a round pipe. This curve is drawn from the test data in Table III. The average velocity is 1550 ft. per min., and the maximum velocity (or velocity at the center), is 1650 ft. per min. The average velocity is found at a distance of 4.2 in. from the center, and if the tip of the pitot tube is located at that point the readings obtained from the gages give average results.

Method 2. The ratio of average velocity to maximum velocity is $\frac{1550}{1650} = 0.94$. If the tip

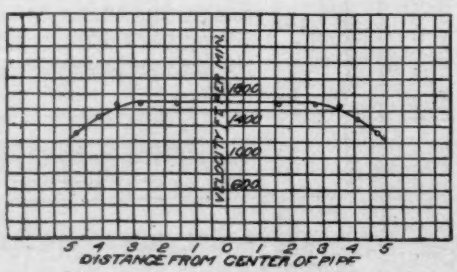


FIG. 2

of the pitot tube is located at the center of the pipe the indications of the gage give the velocity at the center, which multiplied by the ratio gives the average velocity.

The foregoing methods involve preliminary work in order to obtain the proper setting of the pitot tube; but this must be done in any event, whether the apparatus is of the inexpensive type or of the most elaborate design.

The method of computing the proper intervals between pitot tube readings in the average velocity determination may be replaced by the graphical method which is shown in Fig. 3.

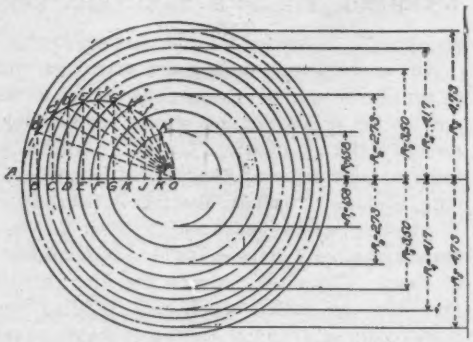
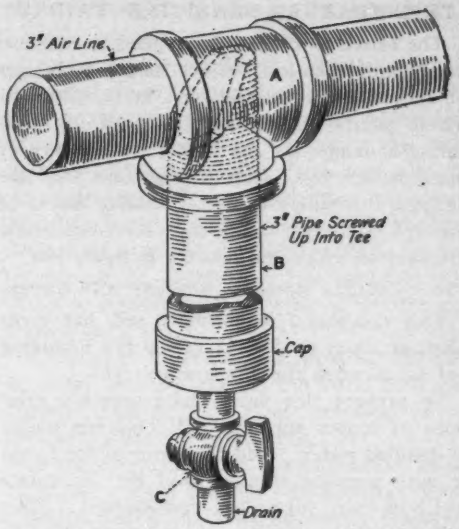


FIG. 3. GRAPHICAL METHOD OF COMPUTING AVERAGE VELOCITY

The large circle represents the round pipe. Upon the radius is constructed a semicircle. The radius of the large circle is divided into as many equal dividends as there are to be pitot tube readings. Erect perpendiculars from each point and through the intersection of each perpendicular and the circumference of the semicircle construct circles with the same center as the large circle. The radius of the inner ring is OJ′, while the radius of the mid-position for the pitot tube is OK′. The construction of Fig. 3 is for the case of the 10-in. pipe mentioned earlier in this article. To obtain a complete traverse of a diameter of the pipe, set the pitot tube at each of the radii proceeding from one wall to the other.

It will be observed that great stress has been laid on the importance of obtaining accurate values for average velocity. This is necessary because local conditions distort the air currents in a pipe and each individual application must be examined by itself.

The internal diameter of the pipe must be carefully measured and the cross-sectional area calculated in square feet. The product of the area and the average velocity is the volume of gas or air moved per minute.



WATER TRAP FOR AIR LINE

DRAINING THE AIR LINE

BY W. B. LAILER

We experienced considerable trouble in the operation of pneumatic chipping hammers at points distant from the source of air supply, due to the presence of water of condensation in the pipe lines, which was discharged through the exhaust ports of the hammers. To eliminate the presence of water in the air before its entrance to the hose line we devised a separating device, which served its purpose admirably. A tee *A* was placed in the pipe line at a point adjacent that at which the hammers were operated. Into this tee was connected a depending piece of pipe *B*, capped at its lower end, forming a reservoir, or well. A drain *C* was provided for removing the water of condensation. This device helped greatly to remedy our trouble, and made unnecessary the use of expensive heating equipment for drying the air.—*American Machinist.*

[The last sentence above may be slightly misleading. Merely heating the air does not dry it, in the sense of removing the moisture, and when the temperature falls the air will be just as "wet" as before. Draining the line by any device that may be employed is always to be regarded as correct practice, but the condensation and precipitation of the moisture previous to the draining is accomplished by the cooling of the air under pressure, rather than by heating it.]

TEMPERATURE-SENSITIVE PAINTS*

The above term has been applied to chemical compounds that are subject to color changes at a comparatively small rise in temperature. These paints are occasionally used for indicating a dangerous rise in the temperature of machine bearings, electric generators and other apparatus where excessive heating has to be avoided. The two compounds described below are easy to make and reliable in operation.

NO. 1—DOUBLE IODIDE OF MERCURY AND COPPER

This compound is normally red, but turns black at about 87 deg. C, (188.6 F.) becoming red again when the temperature falls.

To prepare this paint make separate solutions of copper sulphate and potassium iodide in distilled water. Add the latter to the former with constant stirring until the precipitate which is first formed is re-dissolved. Then add a strong solution of mercuric chloride (corrosive sublimate) and the red double iodide of mercury and copper will be precipitated. Wash and dry this precipitate on filter paper. The red powder may be mixed with a weak solution of gum arabic in water and used as a paint.

NO. 2—DOUBLE IODIDE OF MERCURY AND SILVER

This compound is normally of a light primrose yellow, but turns to a dark orange or brick red at about 45 deg. C, (113 F.) It becomes yellow again on cooling—and it may be heated and cooled an unlimited number of times without losing its curious property, providing it is not overheated.

Make separate solutions of silver nitrate and potassium iodide in distilled water. Add the latter to the former with constant stirring until the original precipitate is dissolved. Then add a strong solution of mercuric chloride (corrosive sublimate) which will produce a precipitate of the double iodide of mercury and silver of a bright yellow color. Wash and dry the precipitate on filter paper. It can be used as a paint by mixing with a weak solution of gum arabic in water.

[It will doubtless occur to some of our readers that these paints could be of service in compressed air practice. For instance, spots of paint No. 2 on the eduction pipes of intercoolers and aftercoolers would become telltales at once if the air were not sufficiently cooled. If there were no aftercooler then spots of paint No. 1 at intervals along the pipe line, and then spots of No. 2 as the distance increased, would show the cooling of the air in transmission. When the normal color returned to the latter spots the air would have given up a large portion of its moisture, which should then be separated and drawn off.—Ed. C. A. M.]

*By W. S. Andrews, Consulting Engineering Department, General Electric Company, in General Electric Review, Feb., 1918.

WASHING AIR FOR ELECTRIC SERVICE

Air washing and cooling are often resorted to for one or several reasons, any one of which may be the predominating reason for its adoption in a specific instance, but all of which deserve consideration at this time of heavy loads long sustained with a shortage of capacity. Washed air, as its name implies, is air that has been washed and being washed is comparatively clean. Clean air reduces the dirt carried over into air-cooled machines, reducing the clogging up of air ducts and vents which interfere with heat transfer and reduces the volume of cooling medium. Moreover, the growth of such materials as dust and dirt increases the fire hazards as these accumulations are readily ignited by flame or arc within the machine. Cooling the air, which occurs during the process of washing or cleaning, enables an increased load to be carried for definite temperature rise of the machine, since temperature drop or gradient between maximum operating temperature and ambient temperature of cooling medium is a factor in heat transfer. Air washing increases the capacity because of the cooling and also because of the reduced amount of foreign matter carried into the machine; and also permits a unit to remain in service longer without being taken out of service for cleaning. Moreover, troubles due to grounds and breakdowns usually are reduced because of the comparative absence of dirt and dust. Washing the air increases capacity, reduces fire risk, decreases labor and enables a unit to remain in service a greater percentage of the time. Air washing may at this time therefore prove a convenient solution to those hard-pressed for capacity, where the load exceeds the capacity and units can be ill-spared for cleaning.—*Electrical Review.*

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CONTENTS

Scarcity of Men Promotes Use of Air.. 8675
Difficult Salvage Problem 8678
Coal Saved by Soot Blowers..... 8681
Portable Light Record..... 8681
Developments in Air Pump Design..... 8682
Displacement Tanks for Air Meters..... 8690
Pitot Tube for Air and Gases..... 8692
Draining the Air Line..... 8695
Temperature-Sensitive Paints 8696
Washing Air for Electric Service..... 8696
The Submarine and the Unsinkable Ship. 8697
Stopping Waste in Boiler Rooms..... 8698
Pneumatic Locomotive Reverse Gear 8698
Compressed Air Operated Vacuum Cleaner 8100
Coleman Oil Burner 8701
Blower for Priming Centrifugal Pumps. 8701
Notes 8703
Patents 8703

THE SUBMARINE AND THE UNSINKABLE SHIP

The submarine is unique in history. This terrific aggregation of inventions, having its birthplace in America, God forgive us! whose sole function is destruction, is at once the most potently and malignantly effective of all. In any comprehensive view of the war, in any attempt to forecast the outcome, it is the one active agency which it is impossible to ignore. Its record of destruction has nothing with which to compare it in all history, and the end is not yet.

We are not forgetting the airplane, nor how the hopes and the fears of the world now concentrate upon it, but it is not pertinent to our present purpose to consider it.

In the employment of the submarine, as we all know, a most peculiar situation has developed, in that it can only be largely employed by one of the two parties arrayed against each other in the great war. Its sole function is to sink ships, and not warships at that, but chiefly those employed in carrying foodstuffs, munitions and fighting men across the seas. But it so happens that the Central Powers have no ships at sea to be destroyed, so that they have practically everything to gain and nothing to lose by the employment of the submarine.

The problem thus forced upon the Allies is to sink or disable the submarines when they can, to avoid or dodge them also when they can, but more especially to so design or so arrange their ships internally that they cannot be sunk by a torpedo. Curiously enough, any inventions toward these ends cannot be in the least available to the submarine gang, for they have no ships abroad to be saved from sinking. Any information concerning the means adopted for making the ships unsinkable cannot be of any use or value to the Central Powers, and can, in fact, have no effect at all upon them except in so far as it may show them how the task which the submarines have undertaken becomes more hopeless. Only discouragement and not encouragement at all can be in it for them, nor anything to help their hellish schemes.

On the other hand, as one thing leads to another nowhere more surely and more constantly then in the line of practical invention, all possible up to date information concerning the inventions which are developing in this line must have a stimulating effect and exert an impelling force upon the brains now trained up-

on the problem of the unsinkable ship, and we may be now and always only certain that further important advances are inevitable in consequence of the revelations.

We have not at all to seek the means of rendering ships unsinkable, but only the manner of application. As sunken ships are now frequently raised by the use of air, it must be in the nature of things a still simpler thing to prevent them by the same means from sinking, and thousands have proposed it.

The scheme of Mr. W. W. Wotherspoon, which has been applied to ships of the U. S. Navy, provides in the design of the ship for many hundred separate watertight, air filled compartments, only a few of which are liable to rupture from any local injury to the ship.

And now comes Mr. William T. Donnelly, Member of the Society of Naval Architects and Marine Engineers, and an acknowledged expert on flotation, with his system of buoyancy boxes. In the ship Lucia where they are placed there are nine or ten thousand of these boxes. They are normally of ordinary pine, 3 ft. long, 2 ft. wide and 1 ft. deep, and to secure water-tightness they are covered with galvanized sheets These boxes are fitted in lines around the ship, both above and below the water line, and fastened to beams where vacant space is available. Boxes also of larger size and of different shape are used in adaptation to available space. In stowing merchandise in ships, boxes of the same kind may be inserted as space fillers any where. The idea apparently has more of common sense then of ingenuity in it, and is none the worse for that. Mr. Donnelly estimates that only 14 per cent. of cargo space is lost in making ships unsinkable by this means, and the cost of thus equipping vessels is put at 10 per cent. of the cost of the ship. No one can well dispute the fact that this device should be given a fair chance for full demonstration as quickly as possible, and in the meantime other devices of equal promise will be equally welcome.

Those who imagine that an aeroplane needs a 300 acre field in which to land will do well to remember that British pilots of the Royal Flying Corps and Royal Naval Air Service, and French pilots also, have flown regularly over the mountains in the Balkans, starting from and landing in little patches of level ground in the valleys.

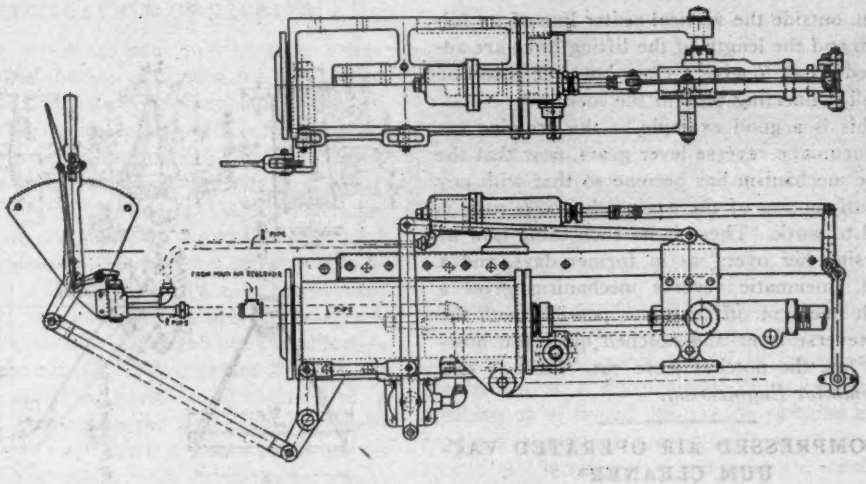
NEW BOOK

Finding and Stopping Waste in Modern Boiler Rooms, is an up-to-date handbook (copyright 1918) compiled by George H. Gibson, assisted by Percy S. Lyon, and published by the Harrison Safety Boiler Works, North Philadelphia Station, Philadelphia. There are 274 pages, 7 by 4¾ inches, liberally illustrated and the nominal price is $1.00. The book is prepared for those who have to do with steam plants, and while originally planned as an advertising publication the formal advertisements are conspicuous by their absence and practically the entire book is a useful compilation of the best information on the design and operation of steam boiler plants. The topics successively treated relate to fuel, combustion, and steam generation, while the uses of the steam, for the development of power, for heating or other purposes are not considered. Tables and charts are given, various references are cited and the contents are carefully indexed.

A PNEUMATIC LOCKING LOCOMOTIVE REVERSE GEAR

An excellent locomotive reverse gear designed by Mr. C. J. Mellin, consulting engineer of the American Locomotive Company, has been brought out by that concern and applied by them to a number of engines which they have recently turned out. The essential feature, or rather one of the principal component parts of the apparatus, consists of an ordinary cylinder with a cup-packed piston and a crosshead with a single guide bar, an operating valve, a locking device and a hand-lever with a latch valve in the cab. What looks like the bottom guide for the crosshead is really a pivoted bar, which may be drawn up at one end and in a sense clamped on the underside of the crosshead, and this really forms a clamp which locks the crosshead and prevents any creeping of the mechanism, due to leakage or from other causes. It is this outside or mechanical system of locking that forms one of the distinctive features of the Mellin gear.

A close inspection of this mechanism shows that the top guide is stationary, and the crosshead entirely encloses it, so that if the lower bar or clamp bar was to fall off it would make no difference to the straight line movement of the crosshead. The action of the clamp bar is simple but effective. On top of the apparatus



PNEUMATIC REVERSING GEAR

is placed what is called the locking device. It consists of a cylinder or case containing a spring at one end of which is a piston moving in a small cylinder which is formed as a continuation of the spring case. It may be said of this design that the locking device is of the friction variety, with the spring case combined with a release cylinder. There is a spring, and connected to the pivoted guide, which by the tension of the spring is magnified through a bell crank leverage, and this force grips the crosshead between it and the main guide. The hand lever latch or lock release valve is a simple poppet inlet and discharge valve, subject to the movement of the hand lever latch, by means of a trigger and bolted to the lever fulcrum bracket.

When the reverse mechanism is about to be used, the hand which grasps the lever puts the latch handle up against the main handle and this opens the small poppet valve, referred to above. Air therefore flows into the ⅜-in. pipe leading to the air end of the spring case. The air pressure so introduced moves the small piston and compresses the spring in its case. In consequence of this, the bolt from the spring case moves back and, through its connections, loosens the pivoted locking bar under the crosshead.

The hinged lock bar or guide must clear the pivoted shoe on the crosshead by ⅛ in. in its parallel position with the main guide, so that it takes an inclined position when locked; giving more inclination when the crosshead is at the inner end of the stroke, and any slight variation in leverage action which exists on the crosshead by the locking guide in and between these positions, is compensated for by the variations in tension of the locking spring, thus securing an approximately uniform locking pressure on the crosshead for any position of its stroke.

The operating valve, placed in the centre, below the cylinder, is of the rotary type, having lap and passages like an ordinary slide valve but without any stuffing box.

In raising the handlever latch in the usual way, the latch valve automatically admits air into the locking cylinder and releases the lock by compressing the spring and remains so until the latch is again dropped and the lock becomes set. The movement of the handlever transmits motion through the floating lever, shown vertically in central position in our illustration, with the crosshead connection to it as a fulcrum, and this movement opens the operating valve. The motion of the crosshead which follows, transmits motion through the floating lever with the handlever connection as a fulcrum, and closes the valve when the gear is stopped and gripped by the lock at the corresponding position of the handlever. At any movement in either direction of the handlever this action is repeated with all parts except the handlever.

In order to hold the valve gear without danger of undesirable movement, the locking guide is brought in contact with the pivoted shoe on the crosshead, the spring link is adjusted so that its connection to the bellcrank is about

¾-in. outside the vertical center line of its fulcrum and the length of the lifting links are adjusted so as to give a close but free insertion of all connecting pins in the lock.

This is a good example of the growing use of pneumatic reverse lever gears, now that the valve mechanism has become so that with any sort of motion of the engine the valve gear is hard to work. There is no such thing now as "horsing her over," as in former days, and a good, pneumatic reverse mechanism gives a much finer cut off than was possible with the old reverse lever and notched quadrant, however fine the notches were cut.—*Railway and Locomotive Engineering.*

A COMPRESSED AIR OPERATED VACUUM CLEANER*

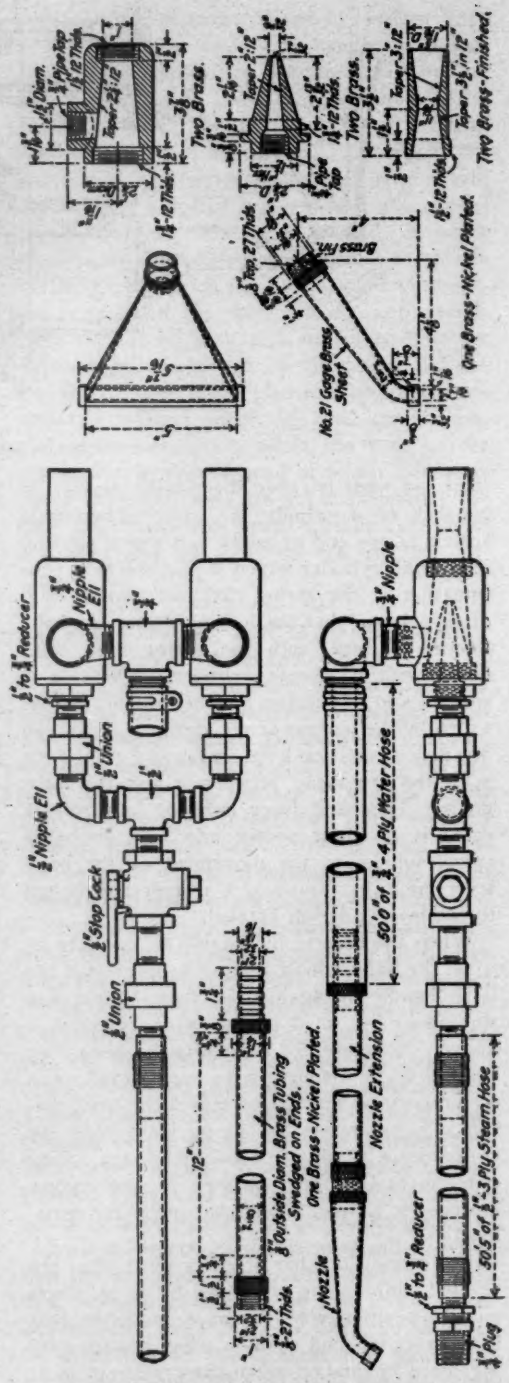
A vacuum cleaner is shown in the drawing which was developed on the Philadelphia & Reading. It has been in successful use on that road for about a year in cleaning passenger cars and offices at points where compressed air is available. The device is intended to be left on the platforms of cars and in the hall outside of office doors while in operation, a 50 ft. length of four-ply water hose being used to make this possible.

One of the difficulties which is experienced with many vacuum cleaners is that they become stopped up, especially in very damp weather, and are not easily cleaned out. It will be noticed that with this cleaner the vacuum chambers may be cleaned out very readily by removing the combining nozzles and turning on the compressed air. The vacuum gage registers about 18 in. when using the cleaner with air pressure at 100 lb. per square inch. Of course, a higher vacuum may be produced if higher air pressure is available.

Little need be said relative to the construction of the device, as the drawing clearly shows all the details. As developed on the Philadelphia & Reading, the parts are made of Brass, but there is no logical reason why cast iron can not be used if desired.

A. U. S. destroyer recently went into drydock after having steamed 25,000 miles, and then requiring only scraping and painting.

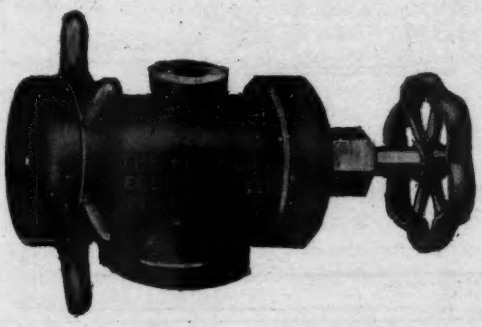
*By Howard W. Stull, Machine Shop Foreman, Philadelphia and Reading R. R., Reading, Pa., in Railway Mechanical Engineer.



COMPRESSED AIR VACUUM CLEANER

DISTILLATION OF LIGNITE

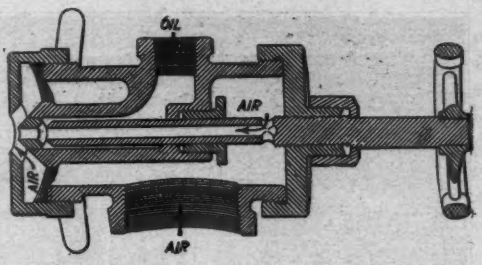
Efforts are being made in France to introduce the distillation of lignite for tars. The Societe de Distillation des Combustibles, Paris, is constructing an improved Ziegler type of furnace similar to that used for the distillation of peat, a type yielding about 7 per cent. of tar which is treated by fractional distillations carried out *in vacuo*, to increase the output of heavy products; followed by chemical purification by washing with dilute sulphuric acid and soda, to remove the picolines, cresols, etc. The crude paraffin, extracted by crystallisation of the heaviest oils, is first passed through the filter-press. The purification consists of a series of filterings in the filter-press, and meltings in light oil. The last traces of oil are removed by scrubbing with super-heated steam, and the paraffin wax is clarified by filtering through animal black. In one place in Germany, where the system was adopted, 70 to 80 per cent. of marketable products were obtained from lignite tar, viz., 15 to 20 per cent. of paraffin wax; 5 to 20 per cent. of kerosene; 5 to 15 per cent. of cresotes and organic acids; the remainder being light products, petrol, etc., or heavy products such as gas oils and lubricating oils.



A FUEL OIL BURNER

We illustrate here, both externally and internally, the Coleman oil burner made by the Foundry Equipment Company, Cleveland, Ohio. It is already numerously employed in foundries on melting furnaces, for core and mold ovens, annealing ovens, ladle heaters and wherever fuel oil is burned, and there is no apparent reason why it should not be as serviceable elsewhere as in the foundry.

In this burner the air supply is connected to the lower nozzle and the air is fed from the main air chamber through a hollow brass stem.



SECTION OF COLEMAN OIL BURNER

The oil is fed around this circular stream of air, and, at the end of the brass stem which controls the oil supply the oil is forced into the stream at a sharp angle. This causes a breaking up of the oil into minute particles and produces a primary mixing with the air. A second and larger outer stream of air, cutting through the primary mixture, produces a further atomization and furnishes the proper combination of oil and air for complete combustion. The ease with which all adjustments are made is self-evident, the construction permitting the feeding of a very small or a large quantity of oil, as well as complete control over the supply of air for combustion.

The burner as here shown provides for a ½ in. oil line and a 2 in. air line, giving a large range of feed for both oil and air. Air at 2 lb. and oil at 5 lb. are quite commonly used, but these burners are in operation under a great variety of conditions as to both pressures.

A BLOWER FOR PRIMING CENTRIFUGAL PUMPS

One of the difficulties met with in the operation of a centrifugal pump is the priming, and for this reason a number of operators are using the plunger rather than the centrifugal type of pump. Various methods of priming have been tried, some of which were successful and others not. The Clearfield Bituminous Coal Corporation at its Rossiter mine, Rossiter, Indiana County, Pennsylvania, has succeeded in devising a priming device that has operated very successfully.

In the pumping room at the foot of the main slope (it is also at the foot of a manshaft) the company has three 600-gal. single-stage Morris centrifugal pumps arranged in a battery. These pumps have separate suction lines, but they all discharge into a main dis-

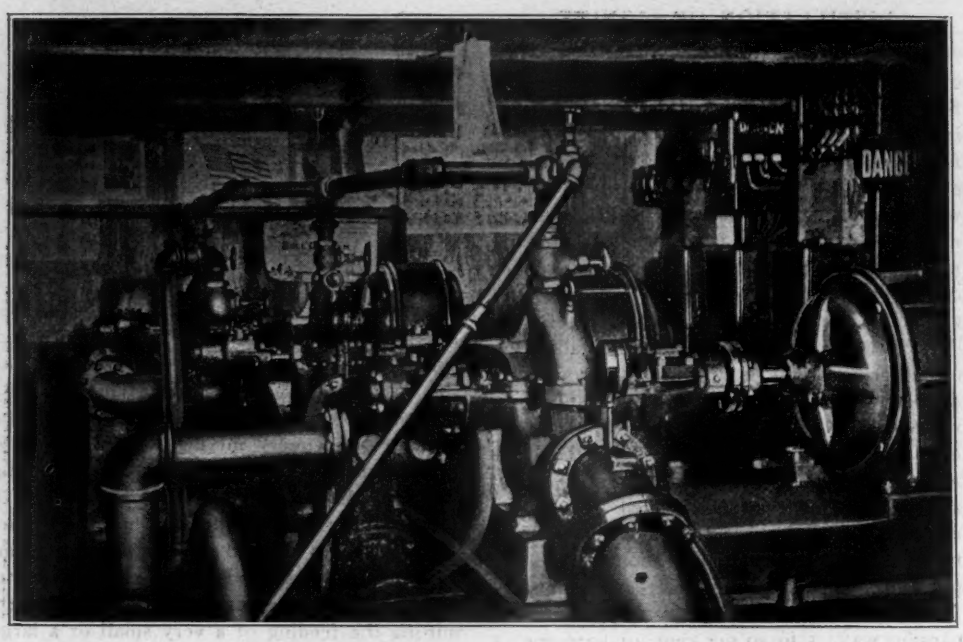


FIG. 1. PUMPING ROOM

charge line that goes up the mainshaft to the surface, making a head of 80 ft. for the pumps to work against. The pumps have a maximum lift of 9.23 ft. on the suction line. The pump-room itself, as can easily be seen in Fig. 1, is built entirely of concrete.

The Clearfield company has had considerable trouble in operating these pumps. It has been difficult to prime them, as they would not start until there was 7 lb. pressure in the discharge line. First the plan was tried of keeping the water in the pumps from running back to the sump by means of foot valves, but these valves would stick and leak, and they caused a great deal of annoyance.

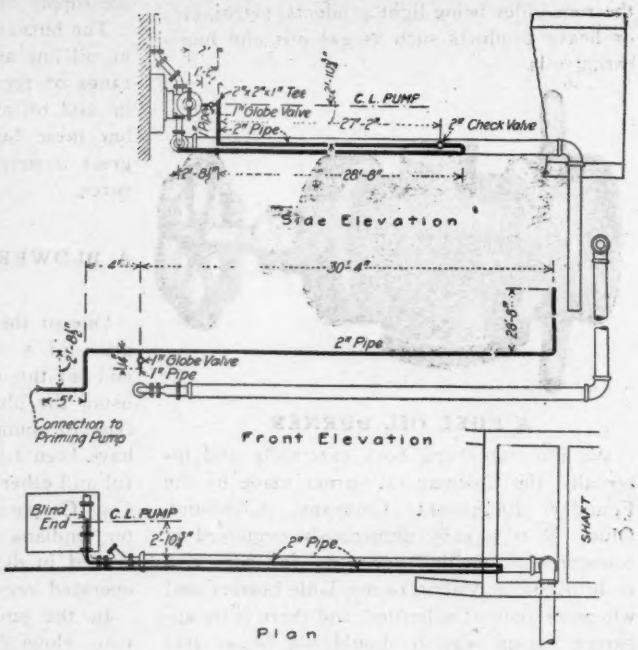


FIG. 2

Next priming was tried by means of an auxiliary pump, an electric-driven plunger pump built by Deming. The water was pumped into the centrifugal pump through the priming hole. Foot valves were placed on the suction pipes, and the plunger pump was run until the water filled the suction pipe and the pump, and rose 14 ft. in the discharge pipe. Then the cen-

trifugal pump was started. This method was found to be too slow, particularly if there were bad leaks in the foot valves, though it is still used in case of emergency.

It was then decided that if a vacuum could be produced in the pump the water would rise from the sump into the suction pipe and then into the pump. This method was found to be successful and much quicker than the methods first tried. Further, it eliminates all trouble due to leaking foot valves.

A 2-in. pipe was connected by branch lines to each of the priming inlets of the pumps, as illustrated in Fig. 2. These branch lines each consist of a 1-in. nipple, a 1-in. globe valve and another 1-in. nipple. The main 2-in. pipe was run to the main shaft, 30 ft. away, and then up a distance of 28 ft. 8 in. This, together with the difference in elevation between the center of the pump and the 2-in. pipe line, makes a total distance of 31 ft. 4½ in., or higher than water will rise in a vacuum. A check valve was placed near the top of the line, and at the top of this pipe a 2-in. return elbow was located, then a 2-in. pipe was run down again to the pumproom, to which was connected a blower operated by a 2-hp. motor.

When it is desired to prime the pumps, the main discharge line valve is closed and the blower started. This sucks the air from the 2-in. pipe, the pump and the suction line, causing the water to rise in the suction pipe, the pump and the 2-in. pipe line. As soon as the water reaches a height of 14 ft., as indicated on a pressure gage at the bottom of the discharge line, the large centrifugal pump is started, the large valve in the discharge pipe opened and the water discharged through this to the surface.—*Coal Age*.

NOTES

To build a tunnel under the Mogi straits, Japan, starting at Shimonoseki and ending at Dairi Fukuoka Prefecture, is the intention of influential citizens of Fukuoka, Kiusha, who will form a company with capital stock of $7,228,250. This tunnel will be connected with the railway trunk line at Kiushu and will be 17,700 feet long. It will extend for 4000 feet beneath the sea and will require five years to complete.

Sugar, states a medical authority, is of all the foods the quickest source of energy, and almost the cheapest. Only the cereals in their coarsest form offer more nourishment for the same expenditure. In no other food has nature stored up nourishment in a form so near that which the human body can utilize it. A spoonful of sugar is actually transformed into body energy in half an hour and less. This quick efficiency has been found useful by athletes and by soldiers on forced marches. Pound per pound, sugar gives a higher fuel value or working power to the muscles than do beans or peas or the cereals when sold in the breakfast food forms.

It is reported that the Gotha airplanes which raid England from time to time, are equipped with apparatus for producing smoke clouds for purposes of concealment. The smoke cloud is usually emitted when the raiders are threatened by anti-aircraft artillery; and since it has the same color and formation as the fleecy clouds overhead, the task of the gunners below is made far more difficult.

Production records at the Baldwin Locomotive Works are being broken weekly. It is reported that in a recent week about 100 locomotives of various sizes were turned out, and President Alba B. Johnson is authority for the statement that the plant is completing a locomotive an hour.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

JANUARY 1

1,251,501. PNEUMATIC ACTION. Charles G. Gilberg, Rockford, Ill.

1,251,641-2-3. SLACK-TAKE-UP FOR FLUID-PRESSURE BRAKE SYSTEMS. George Christtenson, Jamaica, N. Y.

1,251,673. AIR-OPERATED TOY. Charles Koshalko, Cleveland, Ohio.

1,251,734. PNEUMATICALLY-CONTROLLED FRICTION DRIVING MECHANISM FOR IRONING-MACHINES. Fritz Balzer, Chicago, Ill.

1,251,653. STUMP-BURNER. Albert S. Goodwin and Charles C. Hurd, Tacoma, Wash.

1. A stump burning device comprising a blast pipe adapted to enter a hole formed in the stump, means for inducing a draft of air in said pipe, and means for reversing the direction of said draft.

1,251,849. COMPRESSED-AIR-POWER PLANT. Seward S. Vernon, Paterson, N. J.

1,251,954. PROCESS FOR PRODUCING LIQUID OR SOLUBLE ORGANIC COMBINATIONS FROM HARD COAL AND THE LIKE. Friedrich Bergius and John Billwiller, Hanover, Germany.

1. The process of treating products of carbonization of vegetable matter which consists in subjecting them to the action of hydrogen at

elevated temperature of less than 600 degrees centigrade and at high pressure of more than 20 atmospheres until liquid or low-melting-point reaction products of the solid carbonaceous matters are formed.

1,252,103. PAINTING APPARATUS. James S. Gilmer, Knoxville, Tenn.

1,252,178. EVACUATION AND COMPRESSION OF GASES. Edmund Scott Gustave Rees, Stafford, England.

1,252,211. SANDING DEVICE FOR LOCOMOTIVES. William H. White, Roanoke, Va.

1,252,254. METHOD OF AND APPARATUS FOR INJECTING FUEL INTO COMBUSTION-CHAMBERS. Joseph O. Fisher, U. S. Navy.

1,252,614. HOT-AIR SYRINGE. Oscar H. Pieper and Alphonse F. Pieper, Rochester, N. Y.

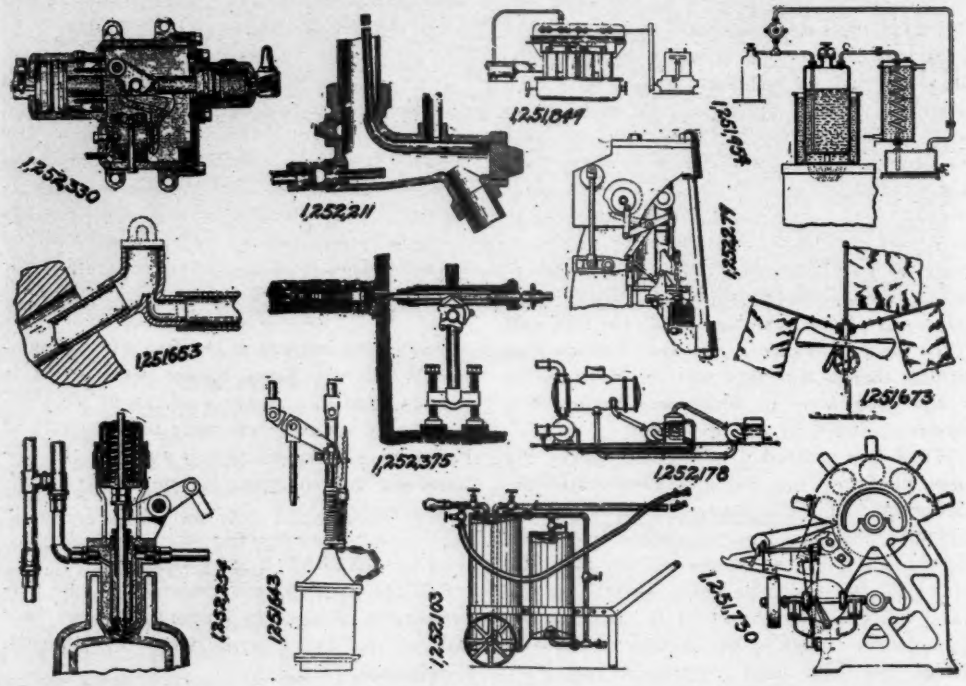
1,252,623. PRESSURE-REGULATOR FOR A FLOW OF FLUID. Charles H. Smoot, New York, N. Y.

1,252,780. DIVER'S HELMET. Ferdinand Ludwig Claren and Hermann Stelzner, Lubeck, Germany.

1,252,799. FLUID-PRESSURE MOTOR AND TRANSMISSION APPARATUS. Edward E. Gray, Plano, Ill.

1,252,904. FLYING-MACHINE. Andrew M. Hirmer, Millvale, Pa.

1,252,905. VACCUM STREET-CLEANING MACHINE. Eddie E. Johnson, Toledo, Ohio.



PNEUMATIC PATENTS JANUARY 1.

1,252,279. WORK-SEPARATING MEANS. Charles D. McDonald, Chicago, Ill.

1,252,280. SUCTION-CUP. Charles D. McDonald, Chicago, Ill.

1,252,330. AUTOMATIC TRAIN-STOP. Adiel Yeaman Dodge, Chicago, Ill.

1,252,374-5. DRILLING-MACHINE. George H. Gilman, Claremont, N. H.

JANUARY 8

1,252,487-8. METHOD FOR ASCERTAINING THE LOCATION OF LEAKS IN UNDERGROUND FLUID-PRESSURE PIPES. George V. Payne, Chicago, Ill.

1,252,490. HYDRAULIC, STEAM, OR AIR VALVE. Nicholas U. Peris, Steelton, Pa.

1,252,508. VENTILATING-FAN. John Stanley Glasspoole Telfer and James Henry Cartner Boyd, London, England.

1,252,557. PROCESS AND APPARATUS FOR INCREASING THE PRODUCTION OF OIL-WELLS. Irwin L. Dunn, Marietta, Ohio.

1. A process of operating oil wells which consists in introducing compressed gas to the oil sand in which the wells are located, maintaining a column of oil in the well to be pumped to exert a back pressure upon the compressed gas, and pumping the oil from said wells.

1,253,026. CENTRIFUGAL REFRIGERATING-MACHINE. Victor J. Goetz, Philadelphia, Pa.

1. A centrifugal refrigerating machine, having intercommunicating high and low pressure chambers to receive the refrigerating and the compressing mediums, and an aspirator operated by centrifugal force on the compressing medium to continuously aspirate the gaseous portion of the refrigerating medium from the low pressure chamber to the high pressure chamber and change it to a liquid.

1,253,030. PNEUMATIC ACTION FOR PLAYER-PIANOS AND THE LIKE. Adolph P. Gustafson, Chicago, Ill.

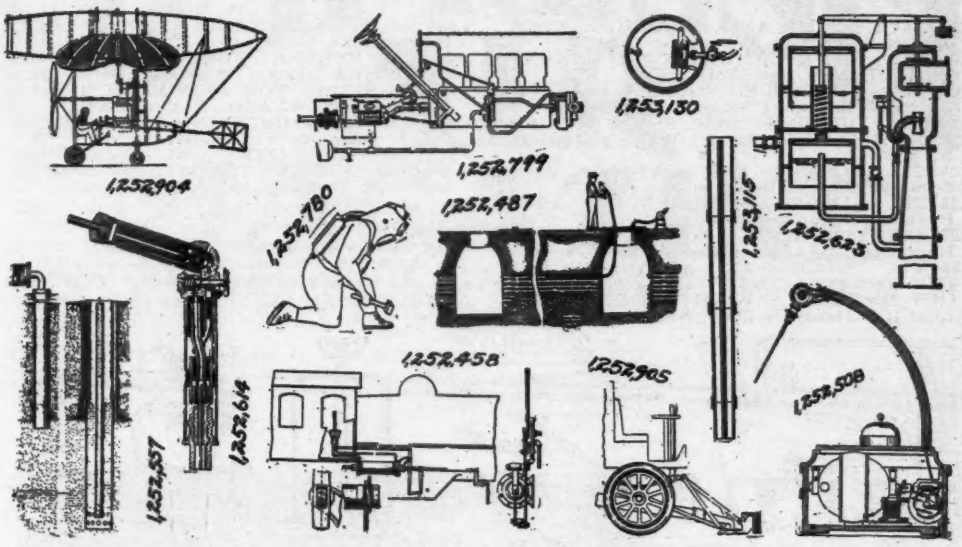
1,253,115. AIR LIFT-PUMP. Charles W. Whitney, Chicago, Ill.

1. An air lift or pump eduction piping composed of a series of cast iron sections coupled together so as to provide a smooth interior, the external diameter of a section being substantially identical throughout its length while the internal diameter is gradually and constantly increased from one end to the other.

1,253,130. AIR-BRAKE MECHANISM. Edward S. Bock, Ellinwood, Kans.

JANUARY 15

1,253,233. ABDOMINAL - MASSAGE IMPLEMENT. William C. J. Guilford, Harrison, Me.



PNEUMATIC PATENTS JANUARY 8

1,253,266. AIR-INLET DEVICE. William Melton, Jr., Neola, Iowa.

1,253,290. ROCK-DRILL. William A. Smith, Denver, Colo.

1,253,291. DRILL-SHARPENER. William A. Smith, Denver, Colo.

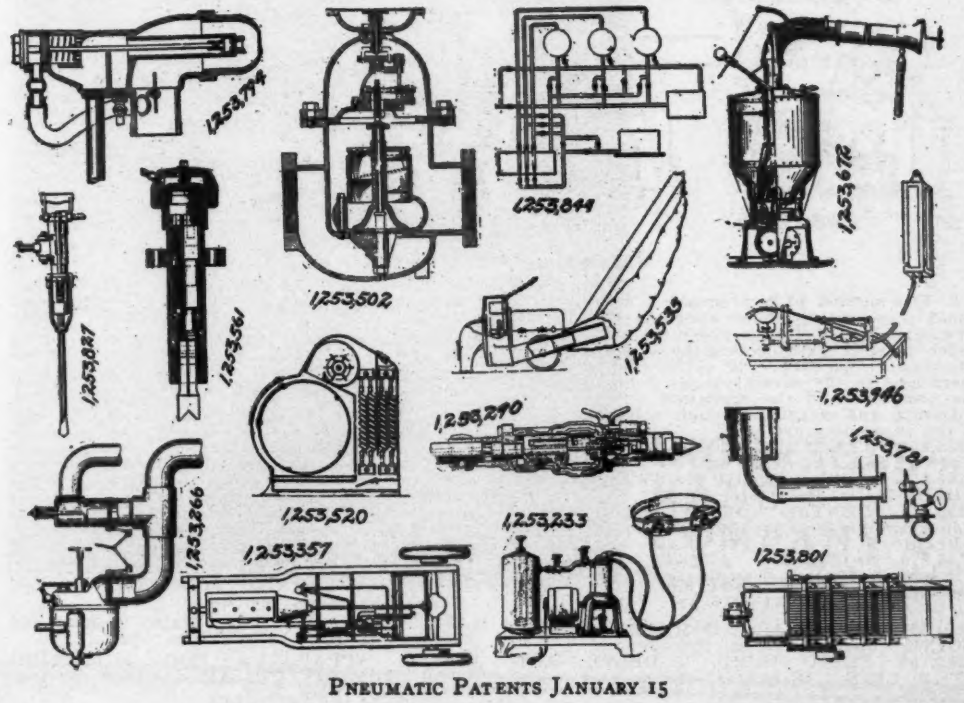
1,253,357. FLUID - PRESSURE - OPERATED APPARATUS FOR STOPPING AUTOMOBILES OR THE LIKE. Eli M. De Lay, Chattanooga, Tenn.

1,253,401. APPARATUS FOR TREATING AIR WITH LIQUIDS. John H. Lorimer, Philadelphia, Pa.

1,253,502. CURRENT FLUID-METER. Frank Lambert, Brooklyn, N. Y.

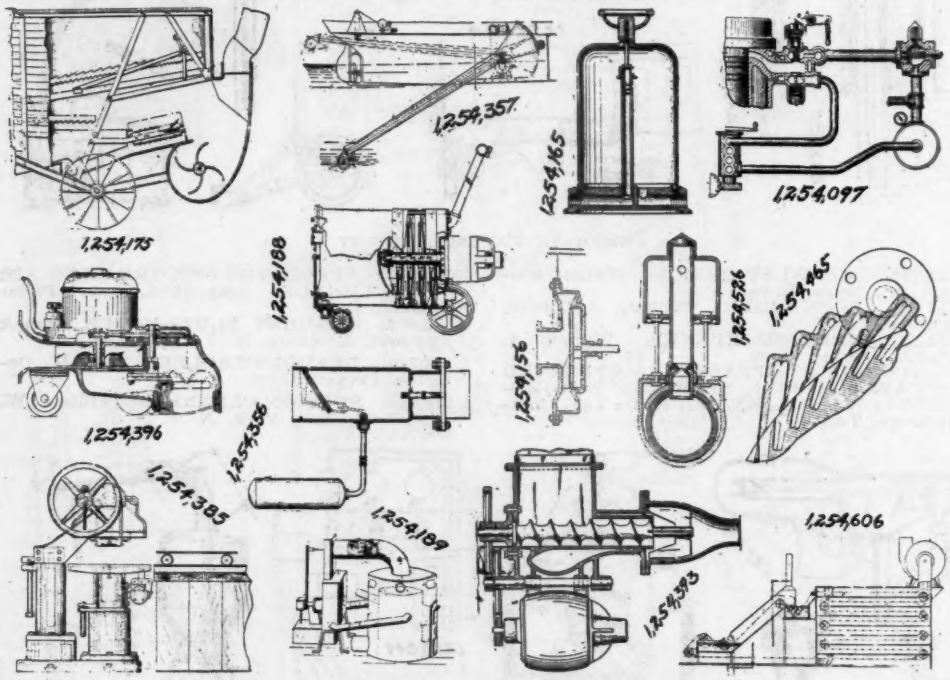
1,253,520. DRYING-TUMBLER. John H. Ostertag, Columbia, Pa.

1,253,535. SUCTION-CLEANER. William W. Rosenfield, New York, N. Y.



PNEUMATIC PATENTS JANUARY 15

1,253,558-9. PUMP AND PUMPING SYSTEM. Burton S. Aikman, Milwaukee, Wis
1,253,561. POWER-ACTUATED IMPLEMENT. Oliver O. App, New York, N. Y.
1,253,650. AIR-COOLED TOOL. Louis J. Van Guelpen, Cincinnati, Ohio.
1,253,672. DUSTING AND SPRAYING APPARATUS. Frederick J. Decker, Rochester, N. Y.
1,253,781. BURNER FOR NATURAL GAS. Zenas H. Brown, Cleveland, Ohio.
1,253,794. AUTOMATIC OIL-BURNER. Albert B. Deem, Indianapolis, Ind.
1,253,827. PNEUMATIC TOOL. Charles A. Hultquist, Los Angeles, Cal.
1,253,844. PROCESS AND APPARATUS FOR IMPREGNATING WOOD AND OTHER POROUS MATERIALS WITH PRESERVATIVE LIQUID. Henry S. Loud, New York, N. Y.
1,254,165. VACCUM-TANK. Karl D. Smith, Battle Creek, Mich.
1,254,175. FEEDER FOR PNEUMATIC STACKERS. Gilbert Thompson, Burns, Mont.
1,254,188. PUMP FOR PNEUMATIC CLEANERS. George W. Allen, Boston, Mass.
1,254,189. AIR-MOISTENING DEVICE. Frederic F. Bahnson, Winston-Salem, N. C.
1,254,356. NEBULIZER AND VAPORIZER FOR INTERNAL-COMBUSTION ENGINES. Henry M. Reichenbach, Detroit, Mich.
1,254,357. SUCTION-DREDGE. John Reid, New York, N. Y.
1,254,385. JAR MOLDING-MACHINE. John T. Anderson, Davenport, Iowa.
1,254,393. PULVERIZED - FUEL AND AIR FEEDER AND MIXER. George W. Clendon, New York, N. Y.



PNEUMATIC PATENTS JANUARY 22.

2. The method of impregnating wood with a liquid preservative under atmospheric, superatmospheric, and hydraulic pressures, successively, which consists in subjecting the articles to such treatment in a three-fold cycle, the coincident operations in the several cycles being different, the completion of the operation in each cycle initiating, and carrying through, a like operation in the succeeding cycle.

1,253,856. TIRE-INFLATER. Melvon A. Marquette, San Francisco, Cal.
1,253,859. AIR - CUSHION SWEAT-BAND. Harry Mertz, Baltimore, Md.
1,253,946. DENTAL - BLOWPIPE BURNER. Jose Antonio De Carvalho, Jr., Rio de Janeiro, Brazil.
1,253,976. DOUBLE - ACTING AIR-PUMP. Robert D. Hughes, Lynchburg, Va.

JANUARY 22

1,254,097. INTERNAL - COMBUSTION ENGINE. Carl W. Weiss, Brooklyn, N. Y.
1,254,156. FLUID PUMP, TURBINE, AND THE LIKE. Richard C. Parsons, London, England.
1,254,396. VACUUM-CLEANER. Clifford C. Dance, Denver, Colo.
1,254,465. ELASTIC-FLUID TURBINE. Oliver D. H. Bentley, Boston, Mass.
1,254,520. COMBINED LIGHT AND AIR TRANSMITTING APPARATUS. Daniel M. Macduff, Detroit, Mich.

1. In an apparatus as specified, the combination of a plurality of connected tubes, means for conducting the sun's rays in pencils through said tubes, means for producing artificial illumination in said tubes, an air vent in said tubes through which the air may circulate, the pencils of light from the sun's rays and from said artificial light being adapted to heat the air and accelerate the circulation thereof.

1,254,526. AUTOMATIC TIRE-PUMP. Michael D. Murray, Ambridge, Pa.
1,254,606. EVAPORATOR. Ralph W. King and Herbert G. Miller, The Dalles, Oreg.
1,254,612. APPARATUS FOR PURIFYING AND HUMIDIFYING AIR. Adolph W. Lissauer, New York, N. Y.